The Engineer

LONDON, FRIDAY, JULY 17, 1942.

PUBLIC NOTICES

EDINBURGH UNIVERSITY

VACANCY

REGIUS CHAIR OF ENGINEERING

The Secretary of State for Scotland announces that he proposes to invite APPLICATIONS for the OFFICE of REGIUS PROFESSOR of ENGINEERING at Edinburgh University.

Applications for the Chair, accompanied by twelve copies of recent testimonials, should be addressed to the PRIVATE SECRETARY, SCOTTISH OFFICE, FIELDON HOUSE, 10, GREAT COLLEGE STREET, LONDON, S.W.1, and should reach him not later than Monday, 7th September, 1942. A note of the terms and conditions of the appointment will be supplied on request. 8616

HERIOT-WATT COLLEGE, EDINBURGH

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The Governors Invite Applications from British Subjects for a LECTURESHIP in MECHANICAL ENGINEERING. Laboratory and Workshop experience are essential. Salary scale £300-£15-£500. Candidates will be placed on scale according to qualifications and experience.

Applications must be made on forms to be obtained with full particulars from the College not later than 27th July.

J. CAMERON SMAIL,
Principal.

8599

SUNDERLAND EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal: F. H. REID, B.Sc., Wh.Ex., M.I. Mech. E.

Applications are Invited for the POST of LECTURER in NAVAL ARCHITECTURE. This is a full-time appointment, commencing on 1st October, 1942. Salary (Burnham Technical Scale), £234-15-£480 per annum.

The commencing salary will include an allowance for approved professional or industrial experience. After three years' service an addition of £20 per annum may be made to the basic salary under Clause 5 (c) of the Burnham Report in respect of "special work of an advanced character."

Candidates must possess a good Honours Degree in Naval Architecture or its equivalent, and should have had experience in industry and teaching.

The standard of the full-time day courses is that required for an Honours Degree, and the evening classes are of Higher National Certificate standard.

Forms of application and further particulars of the post may be obtained from the Secretary, Technical College, Sunderland, Co. Durham. The applications should be returned to the undersigned NOT LATER than Monday, 27th July, 1942.

W. THOMPSON,
Director of Education.

Education Offices,
Sunderland. 8614

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

COMMERCIAL SECRETARY REQUIRED for N.E. Coast Shipyard. Applications should give full particulars of experience, age, wage required.—Address, 8621, The Engineer Office. 8621 A

MANAGER of Small Progressive Works WANTED; experience of Gears and Gearing an advantage.—Address, stating age, experience and salary required, 8635, The Engineer Office. 8635 A

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE

ARRANGED FOR CARD INDEXING

(TABLE OF CONTENTS, PAGE 52)

Non-Metallic Chemical Plant—No. III (P. 44)
(A. E. WILLIAMS) THE ENGINEER, 17 - 7 - 42

Waterloo Bridge (P. 55)
THE ENGINEER, 17 - 7 - 42

The Kingsley Dam—No. II (P. 46)
THE ENGINEER, 17 - 7 - 42

Lightning Protection of Buildings No. I (P. 48)
(E. H. W. BANNER) THE ENGINEER, 17 - 7 - 42

Engineering Education (P. 57)
THE ENGINEER, 17 - 7 - 42

Atlantic Crossings (P. 52)
THE ENGINEER, 17 - 7 - 42

What is Science? (P. 52)
THE ENGINEER, 17 - 7 - 42

SEE PAGE 17

INDEX TO ADVERTISEMENTS, PAGE 59

NOTICE

CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.

This change has been caused by enemy action, and co-operation is earnestly asked for.

SITUATIONS OPEN

DRAUGHTSMAN, About 21, for Maintenance, Clinker Processing Plant; £260 p.a. Air Ministry work. Resident now in Metropolis and free from Essential Works Order. Interviews Saturday afternoons.—Write only, HIBBERTS, Ltd., Thames Works, Vicarage Crescent, Battersea, S.W.11. P4244 A

MECHANICAL ENGINEER MANAGER REQUIRED, London area, permanent post. Qualifications: British University Degree, preferably public school education; age 30-40. Commencing salary £1000 p.a., plus cost-of-living bonus.—Address, P4230, The Engineer Office. P4230 A

OLD-ESTABLISHED SCOTTISH BUSINESS REQUIRES ENGINEER, aged between 30 and 45, as MANAGER for new mill; specialised work.—Write, No. 811, Keith and Co., Advertising Agents, Edinburgh. 8618 A

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TECHNICALLY Qualified ENGINEER, with wide experience of modern Iron and Steel Works Plant, Lay-out, and Designs, REQUIRED for permanent position of CHIEF DESIGNER with combine operating Coke Ovens, Blast-furnaces, Open-hearth Plants, Rolling Mills, &c., in England. Position carries responsibility for supervising detailed development by the Company's drawing-offices of designs for extensive new plant installations. Practical experience of Plant Erection and Operating Maintenance Work an advantage.—Address, 8582, The Engineer Office. 8582 A

SITUATIONS OPEN

CHIEF of RATE FIXING and TIME STUDY SECTION REQUIRED by large Midland Manufacturing Organisation employing 5000 persons, male and female, on war work of high priority. Departments include machine and press shops, sub-assembly and main assembly sections, tool-room, &c. The vacancy calls for a man of good education and thorough technical training, and with some years' executive experience on Rate Fixing and Time Study. Actual experience in rating and build-ups from synthetic data is essential, as well as the ability to co-ordinate and control a large staff. An ample salary is available. Please reply in confidence, stating age, education and full details of experience, together with salary requirements.—Address, 8597, The Engineer Office. 8597 A

PRODUCTION MANAGER.—FIRM Manufacturing Machine Gun Assemblies on Batch Production, employing approximately 600 males and females, REQUIRES MAN with initiative and control, preferably with Time Study experience. Applications will be dealt with confidentially. Full particulars of past experience, present salary, and whether married or single.—Address, 8633, The Engineer Office. 8633 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

UNDER-MANAGER or HEAD FOREMAN WANTED for Engineering Factory on Government work (mostly Non-ferrous) of high priority. Applicants must be fully experienced, accustomed to control and direction of workpeople, having knowledge of Estimating and Ratefixing, Costing, Planning and Progress, and Modern Production Methods generally. Factory is situated in pleasant surroundings in country town in Gloucestershire. Good salary and exceptional post-war prospects in highly progressive firm. Send particulars of career, positions held, &c., in full, stating age, experience in detail, present position, character of work done, availability for release, and salary expected.—Address, 8581, The Engineer Office. 8581 A

HEAD FOREMAN REQUIRED for Small A.I.D. approved Machine Shop, South London area; must be expert Lathe Turner and Capstan Setter, with proved ability. Excellent prospects; permanent position for suitable applicant.—Address, 8605, The Engineer Office. 8605 A

WORKS MANAGER REQUIRED for N.E. Coast Shipyard. Applicants should state full particulars of experience, age, wage required.—Address, 8620, The Engineer Office. 8620 A

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For continuation of Small Advertisements see page 2.

SITUATIONS WANTED, Page 2
AUCTIONEERS & VALUERS, Page 60
BUSINESSES and PREMISES For Sale, &c., Page 60
PARTNERSHIPS, Page 2
PATENTS, Page 2
FOR SALE, Page 60
AGENCIES, Page 2
MACHINERY, &c., WANTED, Page 60
EDUCATIONAL, Page 60
SUB-CONTRACTING, Page 2

For Advertisement Rates see First Column Overleaf

CLASSIFIED ADVERTISEMENTS CLOSE FOR
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***Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of* THE ENGINEER.**

Postal Address,
23, Essex Street, Strand, London, W.C.2.

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CHARTERED STRUCTURAL and Qualified MECHANICAL and WELDING ENGINEER, ex. general works manager, reputable Midlands firm, SEEKS IMMEDIATE RESPONSIBLE MANAGERIAL, PROGRESSIVE APPOINTMENT, London or provinces. Highly experienced home and overseas, acknowledged practical, theoretical, and commercial qualifications; salary around £1000, plus bonus.—Address, P4232, The Engineer Office. P4232 B

CHIEF ENGINEER (43) of Large Admiralty shadow factory DESIRES POSITION with wider scope for his experience—mechanical, electrical, chemical, and civil. Release can be arranged.—Address, 8631, The Engineer Office. 8631 B

CIVIL ENGINEER, M.Inst.C.E., Over Military age, DESIRES APPOINTMENT; extensive experience general civil engineering; excellent references.—Address, P4231, The Engineer Office. P4231 B

ENGINEERING REPRESENTATIVE (48) DESIRES to REPRESENT High-class FIRM. Sound connection, Birmingham, N. Midlands, Staffs, Cheshire, and N. Wales; 20 years' road experience. Highest references.—Address, P4227, The Engineer Office. P4227 B

ENGINEER (34), University Trained, Exp. mech. steam and elect. eng'g., DESIRES RESPONS. POST. Free now. Active and energetic.—Address, P4210, The Engineer Office. P4210 B

ENGINEER, Age 45, A.M.I. Mech. E., Experience in design, erection, and maintenance of steel works, blast-furnace, and colliery plants, SEEKS POST as Chief or Assistant Engineer or Chief Draughtsman.—Address, P4240, The Engineer Office. P4240 B

ENGINEER (50), University Trained, Civil, mech., elec., of wide experience in design, construction, and operation of a variety of specialised plants and engineering works. Salary, £1000/1500. AVAILABLE NEAR FUTURE.—Address, P4236, The Engineer Office. P4236 B

EXECUTIVE ENGINEER, Age 37, A.M. N.E.C. Inst., 1st Class Board of Trade Certificate, City and Guilds, REQUIRES RESPONSIBLE POSITION, where energy, drive, and initiative would have full scope; wide engineering experience. London district preferred.—Address, P4238, The Engineer Office. P4238 B

FITTER ERECTOR SEEKS POSITION abroad; age 40, single; 15 yrs.' Colonial experience.—Address, P4247, The Engineer Office. P4247 B

IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

PRACTICAL ENGINEER (Disengaged), DESIRES EXECUTIVE POST; experience as general foreman, chief inspector, machine shop superintendent, chief maintenance engineer; accustomed to control male and female labour.—Address, P4246, The Engineer Office. P4246 B

PRODUCTION ENGINEER SEEKS CHANGE. Established reputation as authority on efficient production of fine-quality work, including planning, tools, rate fixing, costs, organisation and administration. Age 55. Salary £1300.—Address, P4211, The Engineer Office. P4211 B

SITUATIONS WANTED

MR. J. F. KINCHIN, A.M.I.M.E., will be AVAILABLE to TAKE UP a POSITION as a MANAGER in the near future. He has had many years of practical, technical, and managerial experience in the engineering trade, and is open to contact directors of engineering concerns. Correspondence to 10, Warley Road, Blackpool, with a view to a suitable appointment. 8632 B

R.A. OFFICER, Recently Axed from Army under age regulation (59), med. cat. A, keen, active, served apprenticeship with engineers and shipbuilders, many years works manager large textile works, India, SEEKS POSITION of RESPONSIBILITY offering scope and prospects for enthusiasm and hard work.—Address, P4248, The Engineer Office. P4248 B

SALES MANAGER (Free August), Age 32, DESIRES RESPONSIBLE POST where drive and imagination is needed; wide business experience; would also consider any other appointment with post-war prospects. London area preferred.—Address, P4237, The Engineer Office. P4237 B

WORKS MANAGER (38), A.M.I.C.E., Public school and university, fully experienced production engineer and works administrator. Able to take full control. Proved ability to reorganise or expand production. Thorough knowledge of Factory Acts, A.R.P., &c., as applied in a large factory. Able to obtain release for more responsible work. Salary required about £1250.—Address, P4233, The Engineer Office. P4233 B

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PATENTS

IT IS DESIRED to SECURE the FULL COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENTS Nos. 428,272 and 431,304, which relate to "Universal Joints," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the patentees.—Interested parties desiring copies of the patent specifications and further particulars should apply to STEVENS, LANGNER, PARRY and ROLLINSON, 5 to 9, Quality Court, London, W.C.2. 8610 H

IT IS DESIRED to SECURE the FULL COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENTS Nos. 349,643 and 350,578, which relate to "Multiple-spindle Lathes," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the patentees.—Interested parties desiring copies of the patent specifications and further particulars should apply to STEVENS, LANGNER, PARRY and ROLLINSON, 5 to 9, Quality Court, London, W.C.2. 8611 H

PATENTS AND DESIGNS ACTS, 1907 TO 1942.—NOTICE IS HEREBY GIVEN that W. H. ALLEN, SONS and CO., Limited, and RODERICK CRISTALL McLEOD SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 411,201, entitled "Improvements in or relating to Steam Turbines."

Particulars of the proposed amendment were set forth in the Official Journal (Patents), No. 2790, dated July 15th, 1942. Any person may give NOTICE OF OPPOSITION to the amendment by leaving Patents Form No. 19 at the PATENT OFFICE, 25, Southampton Buildings, London, W.C.2, on or before the 15th August, 1942. P4249 H

THE OWNER of BRITISH PATENT No. 447,457, relating to "Improvements in or relating to Centrifugal Separators," is DESIROUS of ENTERING into NEGOTIATIONS with one or more firms in Great Britain for the purpose of EXPLOITING the INVENTION, either by Sale of the Patent Rights or by the Grant of Licences on reasonable terms.—Interested parties who desire further particulars should apply to ALBERT L. MOND and THIEMANN, of 14-18, Holborn, London, E.C.1. 8624 H

PATENTS

IN THE MATTER of LETTERS PATENT granted to Aiton and Co., Limited, and John Arthur Aiton, dated 4th November, 1926, and 15th September, 1927, and numbered 273,557 and 291,656, for inventions of "A New or Improved Method of Forming Pipe Joints and Means therefor" and "An Improved Pipe Joint and Method of Making same." 1942 A.337.

NOTICE IS HEREBY GIVEN that on the 13th day of October, 1942, an ORIGINATING SUMMONS (1942, A. No. 337), issued out of the High Court of Justice (Chancery Division) on behalf of Aiton and Co., Limited, and Sir John Arthur Aiton (the Patentees), both of Stores Road, Derby, in the County of Derby, asking that the term of each of the said Letters Patent may be extended for five years, WILL COME BEFORE the Honourable Mr. JUSTICE SIMONDS for DIRECTIONS as to the hearing, and that any person desirous of being heard in opposition must at least seven days before that date lodge notice of opposition (giving an address for service within the United Kingdon) at Room 156, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned Solicitors and upon the Solicitor to the Board of Trade.

Dated 7th July, 1942.

COOTE and CO.,
60, Lincoln's Inn Fields, London, W.C.2, upon whom all documents requiring service should be served. 8615 H

THE PROPRIETOR of PATENT No. 480,354, relating to the "Insulation of Tubes, &c., Against the Action of Heat or Cold," DESIRES to ARRANGE by way of LICENCE or otherwise for the EXPLOITATION of the INVENTION in this country.—For particulars write to STANLEY POPPLEWELL and FRANCIS, 88/90, Chancery Lane, London, W.C.2. P4243 H

THE PROPRIETORS of BRITISH PATENT No. 467,895, relating to "Improvements in or relating to Alloy Steels," DESIRE to ENTER into NEGOTIATIONS with one or more firms in Great Britain for the SALE of the PATENT RIGHTS or for the GRANT of LICENCES to MANUFACTURE under royalty.—Inquiries to be addressed to D. YOUNG and CO., Chartered Patent Agents, 21, Bourne End Road, Northwood, Middlesex. 8612 H

THE PROPRIETOR of BRITISH PATENT 511,732, relating to "Door-securing Mechanism," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE or otherwise on reasonable terms for the PURPOSE of EXPLOITING the same and ensuring its full development and practical working in this country.—Interested parties who desire a copy of the patent specification and further particulars should apply to ARTHUR W. PARFITT, of Stafford House, Norfolk Street, London, W.C.2. 8623 H

TO CONTRACTORS FOR SUB-ATMOSPHERIC STEAM HEATING.—ADVERTISERS INVITE INQUIRIES for INFORMATION and TERMS for the INSTALLATION under Licence of their INVENTIONS, protected by Letters Patent Nos. 272,484, 291,134, 359,220, 414,674, 429,684, 458,552, 465,033, 493,597, and 500,318.—Address in first instance Messrs. DICKER, POLLAK, MERCER, TENCH and MEYER, Chartered Patent Agents, 20-23, Holborn London, E.C.1. 8609 H

SUB-CONTRACTING

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JEWELLERY FACTORY, Central London, 15 workmen, capacity 40, WANTS STAMPING, TURNING, and DRILLING SMALL PARTS SOFT METAL.—Address, P4245, The Engineer Office. P4245 MW

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WANTED, a FIRM to UNDERTAKE GRINDING, POLISHING, and HARDENING SMALL HAMMER HEADS. Government work.—Address, P4242, The Engineer Office. P4242 MO

For continuation of Small Advertisements see page 60

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A Seven-Day Journal

A Singing Propeller Problem Solved

MANY problems have arisen and have had to be solved in the large mercantile shipbuilding programme which is being carried through in British and American shipyards. One of these problems, news of which has recently reached us, concerns the diagnosis and cure of singing propellers. We may recall that the standard tramp steamers constructed in both British and American yards are built to British designs, and are generally similar, except that in regard to auxiliaries and fittings, the nearest American equivalent has been adopted, having regard to the position in respect of labour and materials. Thus, in the American ships bronze working propellers are fitted, while in the case of the British-built ships cast iron propellers are employed. On the arrival of one of the first American-built ships at a British port, it was reported that trouble had been experienced with a singing propeller. At first this trouble was puzzling, as the propeller design had been prepared with due regard to the avoidance of singing. When the ship was dry-docked the propeller was removed and taken to the works of a local firm, where it was carefully examined by Professor W. Kerr, of the Royal Technical College, Glasgow, who has done a lot of research work in connection with singing propellers, and who collaborated with Mr. J. F. Shannon and Mr. R. N. Arnold in a paper on that subject, read before the Institution of Mechanical Engineers in April, 1940. The examination disclosed that although the propeller was in accordance with the design as regards its general features, certain streamlining at the edges of the blades was not quite as it should be. It was rectified under the supervision of Professor Kerr, and the propeller was then refitted to its shaft. Subsequent service records of the ship show that the alterations which were made cured the singing at all conditions of loading of the ship. Similar amendment is now being applied to the propellers of other vessels of the group, which have been reported as having singing propellers, and to any of the propellers which it is intended to fit to further ships of this class. Professor Kerr's accurate diagnosis of the cause and the quick rectification of the trouble is worthy of record.

The Society of Chemical Industry

AT the annual meeting of the Society of Chemical Industry, which took place on Friday, July 10th, at the Royal Institution, London, Dr. William Cullen was re-elected President. In his address he reviewed the growth of the chemical industry in the fifty years during which he had been a member of the Society. He made a plea for greater co-operation between the chemists of all countries to advance their science for the benefit of mankind. A good deal of overlapping could be avoided, Dr. Cullen said, if such an object could be attained. After the war he thought that there would be great opportunities for service for all industrial chemists. If we were to maintain our present standard of living, one thing was certain, whether we won or lost the war, we should undoubtedly have to work much harder in the future than ever we had done before. The Messel Medal was presented to Sir John Russell, Director of the Rothamsted Experimental Station, and the Imperial Bureau of Soil Science, who spoke on chemistry and agricultural reconstruction. The necessity for wise planning was, Sir John said, particularly true of agriculture. Under pre-war conditions, only 40 per cent. of our rich and varied dietary was produced in this country, and the remainder was imported. After the war if we were to attain to anything like the same standard, it could only be done by careful planning at home and well-designed arrangements with overseas exporting countries. Perhaps the most difficult problem we had to face in the future would be to preserve the freedom for the scientific worker, without which progress in science was impossible, and at the same time to ensure the full application of science to the problems of industry and agriculture. In Germany pure science had suffered, but there had been successful applications of science to all war activities. We, on the other hand, had been more successful with pure science, and our problem now was to obtain equal success in applying it to our national needs.

The Late George Christopher Lloyd

MANY engineers will learn with regret of the death, on Friday, July 10th, in a London nursing home, following a short illness, of Mr. George Christopher Lloyd, Honorary Secretary of the Iron and Steel Institute. Mr. Lloyd, who was eighty-one years of age, was the son of the late Rev. C. A. Lloyd, Rector of Rand, Lincolnshire, and was educated at a Moravian School in Baden. He received his engineering training with Robert Stephenson and Co., and, taking his Extra First-class Board of Trade ticket, he served as engineer in ships of the Lamport and Holt Line and the Compania Trasatlantica de Vapores Correos, Barcelona. At a later date Mr. Lloyd represented the Mirrlees Watson Company, Ltd., in Germany, Austria, and France. His next appointment was with Jeremiah Head and Son, who represented the Wellman Seaver Morgan Company, of Cleveland, Ohio. For some time he was assistant secretary to the Iron and Steel Institute under Mr. Bennett Brough, and in 1904 he was elected secretary of the Institution of Electrical Engineers. In 1909 he became Secretary of the Iron and Steel Institute which he served for twenty-four years, retiring in 1933. On his retirement he was appointed Honorary Secretary, a position he continued to hold until his death. During his period of office the research committees which had previously been set up were re-formed as Joint Research Committees with the British Iron and Steel Federation, as the Ingot Committee, the Corrosion Research Committee, the Alloy Research Committee, and the Steel Castings Committee. During his secretaryship many happy and useful Autumn Meetings of the Iron and Steel Institute were arranged in Great Britain, on the Continent, and in America, at which Mr. Lloyd, one of the best-known men in the world's iron and steel industry, always took his own part. He will long be remembered for his old-world courtesy and charm, and his skill in handling men and situations.

The "Sten" Gun

FURTHER particulars have now been released by the Ministry of Supply with regard to the design and production of the "Sten" machine-carbine or sub-machine gun. The name of the gun is derived from the first letter of the names of the two people most closely associated with its design, "S" and "T," and "EN" for England. The men are attached to the Ministry of Supply Armaments Design Department, and are part of a team engaged on armaments design. They set to work, and in December, 1940, began the design. Within a month not only had the gun been designed, but the prototype had been completed. It was demonstrated to the War Office and other Departments, and by 1941 the first order for 100,000 had been placed. The new gun fires almost as fast as the American Thompson sub-machine gun, and as fast as the German Schmeisser sub-machine gun. It weighs less than either of these guns, and has fewer parts. Whereas the Schmeisser has 104 parts and the Thompson 90 parts, the "Sten" has only 59 parts, including the washers and pins. The gun is as accurate as any of its own class, and the over-riding consideration in design was that it was to be capable of being produced in well-dispersed plants. Instead of the orthodox butt, simple stem and shoulder pieces of mild steel were substituted. The action of the gun is very simple, and it works on the gas-ejection principle. Wherever possible, welded joints are used, and in order to reduce the number of skilled operators, gas welding was freely adopted to allow as many women as possible to be employed on the construction of the gun. The problem of the design of the barrel, always a bottleneck in small arms production, has been solved in an ingenious way, and because of the ingenuity and skill displayed in design, this remarkably effective weapon is now being produced in tens of thousands per week.

Employment Returns

IT was announced by the Ministry of Labour and National Service, on Thursday, July 9th, that the number of men and boys registered at Employment Exchanges in Great Britain as wholly unemployed at June 15th, 1942 (exclusive of men, numbering 24,870, who had been classified by interviewing panels as unsuitable for ordinary industrial employment), was 62,766, showing a decrease of 3005, as compared with May 11th. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 1861; this was a decrease of 738 as compared with May 11th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 3002, showing an increase of 51 as compared with May 11th. The corresponding figures for women and girls at June 15th, 1942, were 36,474 wholly unemployed (exclusive of those, numbering 1374, who had been classified by interviewing panels as unsuitable for normal full-time employment), 1809 temporarily stopped and 258 unemployed casual workers. Of the 36,474 wholly unemployed, 1445 had been classified as unable for good cause to transfer to another area. As compared with May 11th, the numbers wholly unemployed showed a decrease of 6718, those temporarily stopped a decrease of 1381, and unemployed casual workers a decrease of 23. During the period under review the greatest drop in the number of unemployed persons took place in the London and South-Eastern Districts, the Eastern and South-Western Districts, and Scotland.

Daylight Raids on Danzig and Flensburg

IT was announced by the Air Ministry on Monday, July 13th, that on Saturday evening, July 11th, several squadrons of the latest "Lancaster" heavy bombers attacked important submarine building yards at Danzig and at the Port of Flensburg on the Baltic. The outward journey, the report states, was performed under difficult conditions for the crews of the aircraft, which encountered violent winds, thunder clouds, and sudden storms. The machines were thrown about by the winds, and some of them failed to locate their targets, but, nevertheless, the attack was pressed home and was made well below cloud base, enabling the shipyards to be heavily bombed. Equal success was achieved at Flensburg, where the submarine-building yards were attacked from a very low level and bursts were reported on the slipways. The only machines which were reported missing after these outstanding raids were three aircraft of Bomber Command. The length of the journey involved was 1750 miles. Danzig is one of Germany's important submarine-building centres. It has been largely developed because it was regarded as being more outside British bombing range than some of the better-known German shipbuilding yards. The yards at Danzig include those of the Danziger Werft und Eisenbahnwerkstätten A.G., formerly the International Shipbuilding and Engineering Company, Ltd., with extensive berths, floating docks, and repairing facilities, and one of the Schichau G.m.b.H. shipyards, both of which have, it is believed, been specially developed for submarine building and repair work. At Flensburg there is the shipyard and engine works of the Flensburger Schiffbau Gesellschaft, which is a well-equipped building and repair yard.

Non-Metallic Chemical Plant

By A. E. WILLIAMS, F.C.S.

No. III

(*Continued from page 27, July 10th*)

Glass Pipe Lines

THE obvious big advantage of glass pipe lines is their transparency, enabling visual inspection of flow, quality and state of cleanliness of the line. The type of glass which has been developed in this connection is borosilicate glass, and this is used in the production of Pyrex pipe lines by J. A. Jobling and Co., Ltd., Sunderland. These glass pipe lines have an inertness to chemical action similar to the materials already mentioned, while their strength is ample for a wide range of conditions obtaining in chemical factories. For example, they will operate satisfactorily at pressures up to 50 lb. per square inch and in some cases pressures up to 100 lb. per square inch may be used. The glass is unaffected by sudden and wide temperature fluctuations. The lines, for example, may be flushed with hot water or steam or hot acid solutions without any effect on their properties. This is due to the low thermal expansion coefficient of the borosilicate glass.

For supporting the glass pipe lines standard pipe hangers may be used, the bottom of the hanger being covered with a resilient sleeve to avoid scuffing or cutting during installation. Hangers are placed at distances which vary with the material carried by the line. When this material is a gas the hangers may be from 10ft. to 12ft. apart, according to the bore of the pipe. For heavier material, like sulphuric acid, the hanger spacing is from 7ft. to 10ft. Glass piping is made in standard sizes of bore from 1in. to 3in. and in lengths of 6in. to 5ft. or more. The pipe ends have conical flanges and joints are made by compressing the flanges to a gasket by means of metal flanges and clamping bolts, the method of assembly being made clear in Fig. 11. The gaskets are self-centring and are held in position by the flange bolts. In assembling the lines work should proceed, preferably from a fixed point in the system, the pipes being in hangers, with malleable flanges loosely in place. The faces of abutting pipe ends are then checked for parallelism and the gaskets inserted between them. The flanges are drawn together with faces parallel by a uniform tightening of the nuts in rotation, about one-quarter turn being given each nut, so ensuring uniform compression of the gasket and a tight joint. When it is necessary to connect the pipes to a metal pipe line coupling is easily effected by drilling and tapping a blank flange to the bolt circle dimensions, aligning the glass and metal pipes, inserting the gasket and tightening as for any all-glass pipe joint.

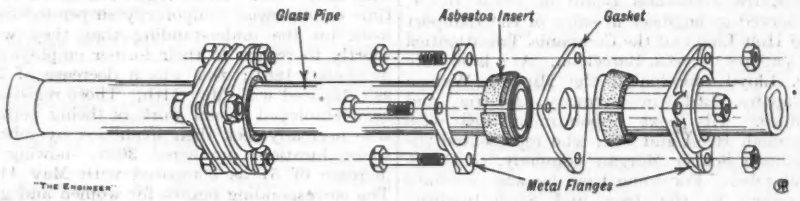


FIG. 11—ASSEMBLY OF GLASS PIPE

Synthetic Materials

Materials with a synthetic resin basis are comparative newcomers to the realm of chemical plant manufacture, having been developed chiefly since the last war. Their use is now very widespread to meet the corrosion problem, and they are at least as resistant, in general, as other non-metal materials. Moreover, owing to the nature of the synthetic materials, their composition may be varied widely to suit the purpose in view, and they can be made to resist even hydrofluoric acid and its compounds, while other grades are resistant to alkalis. This synthetic material differs entirely from the plastic mouldings, produced from moulding powders, found almost everywhere nowadays in the shape of door knobs, electric switches, &c. Unlike most other non-metal materials for chemical plant construction, the synthetic product is readily machinable and may be sawn, drilled, &c., with the same facility as a hard wood. In this country the chief material of this nature is "Keebush," made by Kestner Evaporator and Engineering Company, Ltd., London, S.W.1. The mechanical strength of "Keebush" is high, for it has a bending strength of about 6700 lb. per square inch, and a compressive strength of about 10,000 lb. per square inch. It can be used safely at temperatures up to 130 deg. Cent., and is therefore suitable for the construction of boiling tanks, pickling vats, steam ejectors, &c. Rapid temperature changes do not affect it and in many chemical processes this property makes for a saving of time. Because of its good heat insulating properties a considerable saving of heat is possible through its use.

The various types of apparatus made of "Keebush" are produced by well-developed moulding processes and it is possible to produce rapidly large and complicated items of plant in one piece without joints or seams. Larger sizes are moulded in two or more pieces and then coupled together by a simple form of flanged and bolted joint. Fig. 12 depicts a row of absorption towers constructed in this material, which form part of a special process plant producing materials for the war effort. These towers are designed to

FIG. 12—"KEEBUSH" ABSORPTION TOWERS

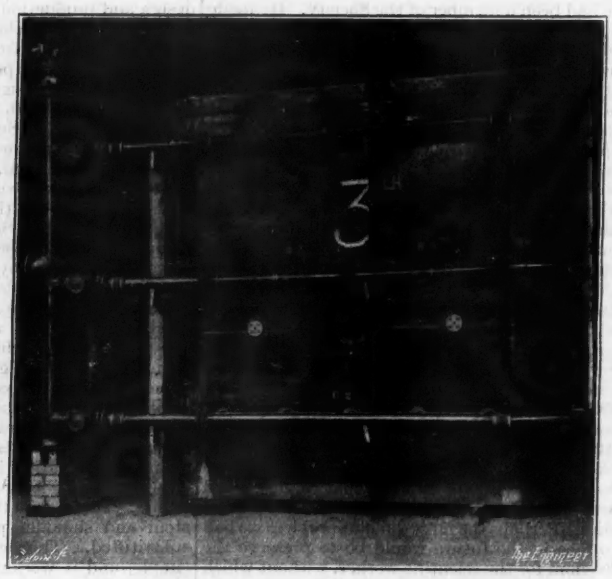


FIG. 13—SECTION OF "KEEBUSH" CHLORINATION TOWER

work at a pressure of 30 lb. per square inch and are tested hydraulically to 60 lb. per square inch. A new method of providing a flanged joint between the tower and the cover has been evolved which enables production costs to be reduced, while, at the same time, the strength efficiency of the joint is greater than with previous moulded constructions. Towers may be made in sections up to 9ft. diameter and 10ft. deep, which are then assembled by means of steel flanges and a spigot and socket connection. The usual connections for steam, gases and liquids are fitted, as also are grid plates to support fillings, manholes, &c. In Fig. 13 there is shown a section of a pulp chlorination tower, the sections being 10ft. deep by 8ft. wide, and the complete tower when assembled is 40ft. high. Each section is made in one single piece, the only joints being the horizontal spigot and socket joint between each section. The chlorine injection pipes at the front and

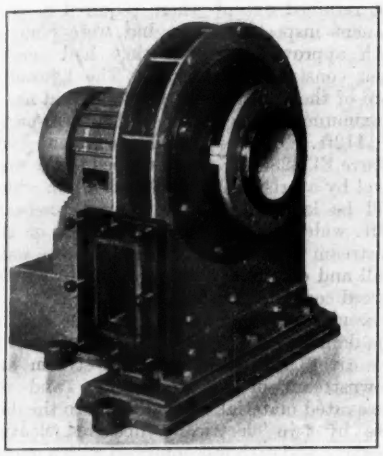


FIG. 14—"KEEBUSH" FAN

interconnecting mains and also the valves are all made of "Keebush." Chlorine is injected into the tower under pressure by means of the fan, Fig. 14, which is direct driven by electric motor. This fan has the entire casing and impeller made in the synthetic material, supported on a steel frame. The impeller, owing to its great strength in relation to its density, can be run at a high peripheral speed, giving a water gauge pressure which could not be obtained with metal or non-metal materials of a heavier nature. The normal speed of the fan is over 3000 r.p.m. Both high-pressure and low-pressure fans are made in this material for handling gases and vapours of a corrosive nature.

A complete process plant, all constructed of "Keebush" with the exception of the steam-jacketed boiling vessel in the centre, is shown in Fig. 15. This plant, which comprises receivers, acid eggs, pumps, pipe work, separators and reaction vessels, is in use in the drug trade producing a valuable pharmaceutical product which would be contaminated if produced in metal equipment. Tanks of large dimensions are reinforced, generally either with steel bands or, as in the tank on the left of Fig. 15, with wooden staves and steel hoops. Rectangular tanks may be moulded in one piece up to a length of 10ft., without seams or joints, longer tanks being made up by connecting sections together by flanges and bolts. Pipes of the synthetic material are made in all standard sizes from ¼in. bore upwards, and in lengths up to 10ft. They are usually connected by cast iron flanges set back slightly from the face of the pipe, which is machined to permit of a butt joint being formed. Pipes may also have other types of connection, such as spigot and socket, cone end with flanges, or of the screwed and socket pattern. Valves are generally made of the Saunders patented form, the body being made of "Keebush" and the diaphragm of specially selected materials to suit specified working conditions. A glandless valve of this type eliminates the trouble often caused through corrosion and leakage in an acid valve. Pumps constructed of the synthetic material are of two types, the Kestner patented glandless pump and the ordinary horizontal or vertical pump, and are made in sizes from ½in. to 4in. diameter. A typical pump of this material will handle 30,000 gallons per hour at 40ft. head.

A recent innovation in connection with plastics as applied to chemical engineering is represented by the casting of transparent pump bodies, valves, &c., from synthetic resin materials of the phenolic type. The advantages of transparency in a pump body or other apparatus are that it is an aid for instructional purposes, facilitates inspection and may help in elucidating some problems in connection with design. However, this transparent equipment is still in its infancy and its present limited characteristics do not yet make it a universal substitute for other non-metallic materials.

ACID-RESISTING WOOD

The war has affected timber supplies to this country very considerably and the supplies of special wood used in chemical plant construction have diminished proportionately. Wood is employed in the making of containers and storage vessels for a great variety of chemicals, and wooden storage tanks are built with a capacity up to about two million gallons. In normal times California redwood is greatly in demand for the building of large-size vessels, but at the present moment stocks of redwood in this country are low and little of this timber is being imported. Redwood successfully resists weak mineral acids and also most organic acids, and many of these, such as tannic and acetic acids, even at boiling point, can be stored in redwood vessels. Teak wood, of which the Burma variety is generally accepted to be the best, is suitable both for acids and alkalis, and it also has a high resistance to moisture. For tank construction in which the planks need not necessarily be of great width, teak is as economical as any other good class of wood. Although stocks of teak in this country are not yet exhausted there is little likelihood of further supplies becoming available until Burma is freed of enemy hands. Oak is used both for storage vessels and for mixing vats. In this latter capacity it has a high resistance—due to its exceptional hardness—to the abrasive action incurred in the stirring and mixing of chemicals. As the war continues English oak will increasingly become the standard timber for tank construction, as supplies here are good, while stocks of other suitable timber will gradually diminish and in most cases will not be replaced to the necessary extent until the end of hostilities. Pitch pine, with its high resinous content, is favoured mainly for tanks to hold cold liquids, as elevated temperatures tend to bring out the resin from the wood. The extraction of the resin in this way often causes shrinking of the inner surface of the wood, but such shrinking is usually confined to the inner surface and actual leakage is seldom caused through this defect. There are still good stocks of pitch pine in this country, but none is being imported. Larch wood from Siberia has in the past been found useful for making chemical vats, but as this wood is also not being imported at the moment tests are being carried out with English larch wood, of which small quantities are available. From Russia small shipments of red deal are being made to British ports, and this is a useful wood for chemical purposes where the corrosion problem is not severe. Other woods normally used in British chemical industries include kauri pine from New Zealand, and Douglas fir and red cypress from America. The imports of these woods have been stopped temporarily and only limited supplies are available here.

All timber used in the construction of chemical tanks and vats should be well seasoned, and the sawn planks should be left at least two years before being used. During this seasoning period, especially with high-resin woods, such as pitch pine, the planks

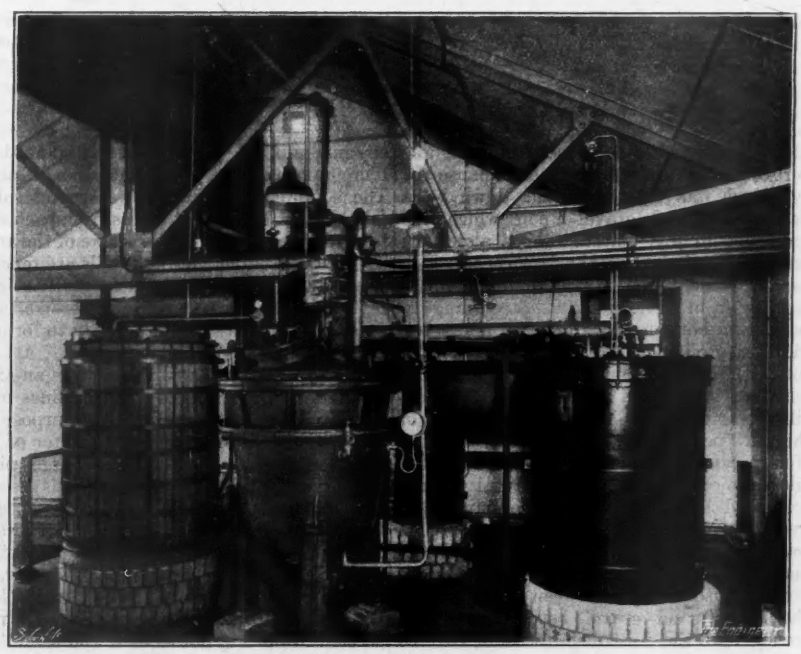


FIG. 15—"KEEBUSH" PHARMACEUTICAL PLANT

of highest resin content will become known by a deposit of resin on the surface, and such wood is generally not selected for the construction of tanks to contain hot chemicals. With some woods an improvement in their resistance to certain chemicals is obtained by impregnating the wood with paraffin wax or similar material. The usual laboratory method of testing wood as to its suitability for use in the presence of a certain chemical consists of merely immersing a small piece of the wood in the chemical for a specific period at a given temperature, and noting the effect on the wood. However, this method is not a satisfactory criterion as to the suitablility of the wood for a particular purpose; for in such an immersion test the more vulnerable end grain of the wood is exposed to the chemical action, whereas in actual practice the end grain of a wooden vat or tank is never immersed in the chemical. For this reason the laboratory method is an unreliable indication of the suitability of a wood for a specific purpose and a satisfactory test can be obtained only by a trial with a small vessel made up of the wood concerned and operated under actual working conditions.

The Kingsley Dam

No. II

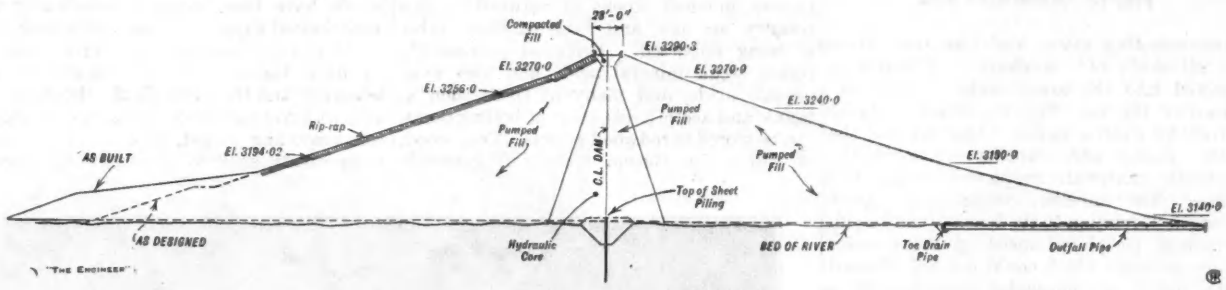
(*Continued from page 38, July 10th*)

The Kingsley Dam

THE site chosen for the Kingsley dam was the most promising of seven examined, and a great number of exploratory drillings was made to ascertain the nature of the underlying ground for foundation purposes, and also to determine the availability of materials for both the core and the shell of a projected dam. An earth-fill dam hydraulically placed was the logical and economical type of structure in the river valley, because the nature of the river bed and its depth above base rock made prohibitive the necessary excavation for the erection of a masonry dam. Work in connection with the structure began by building across the flood plain of the river, both upstream and downstream of the dam site, toe dykes for excluding water from the intermediate area from which the dam was to rise, and within this enclosed expanse the river bed was cleared of silt down to a stratum of sand gravel upon which the hydraulic fill was placed. Next, along the axis of the main body of the dam a core trench was excavated, having minimum depths ranging from 10ft. to 20ft., according to location, a bottom width of 11ft., and a top width at ground level varying from 50ft. to 30ft., the sides sloping 1 : 1. Along the centre of this trench a cut-off of steel sheet piling was driven, so that the lower ends of the piles penetrated the underlying stratum of impervious Brule. The top ends of the piles projected above the natural ground level and into the base of the impervious hydraulic core of the dam. The core trench was filled with mechanically compacted core material. Before any hydraulic fill was pumped into the area between the toe dykes, the bared sand gravel between the core trench and the upstream toe was covered with a blanket fill of loess, which had a minimum thickness of 3ft. after rolling. Downstream of the core trench the pumped fill rests directly on the exposed sand gravel of the river bed. The cut-off wall of steel sheet piling, which extends north across the valley a distance of 9700 ft., is made up of piles that vary in length from 40ft. to 165ft., according to location. At the south end the steel sheet piling cut-off adjoins a concrete cut-off wall at the two large discharge conduits, and the concrete core wall extends thence further southward to meet a concrete curtain wall, that brings the cut-off structure to an end against the bluff, to which the dam is tied where it meets the high ground on that side of the river.

As is the practice in building dams by the hydraulic-fill method, the dredged fill is discharged from large delivery pipes paralleling the sand dykes on the upstream and downstream limits of the dam and supported on temporary trestles just inside the fill area. The soup-like mixture of water and solids falls on to a beach that slopes from each side toward the core pool in the centre of the area. The coarse and heavier materials are quickly precipitated on the beach, incidentally raising it, while the fines and the water continue down and into the pool ordinarily to form as they settle the impervious core. At the Kingsley dam, loess was added from an axial discharge pipe to supplement the fines from the dredged material for the purpose of intensifying the impervious character of the core. The flanking 30in. discharge pipes were re-established nearer the axis as the body of the dam mounted with each succeeding lift of deposited material. The waste water from the core pool and a percentage of the fines were carried off by drains arranged along the axis of the dam. These drains were formed of corrugated metal pipe sections dipped in hot asphalt and assembled as vertical shafts reaching from the pool level down to elbows near the ground level. The elbows connected with corrugated metal pipe, 48in. in diameter, extending upstream to the toe of the dam, where the waste water entered flumes reaching still farther upstream to the outer edge of a loess blanket laid upon the river bed for an upstream distance of about 900ft. The core pool was thus drained at longitudinal intervals averaging about 960ft. at ten points. The downstream pervious shell of the dam is drained by a perforated drain pipe, laid in a trench with gravel fill. This pipe generally parallels the toe line of the dam inward a distance of 250ft., and discharges through outfall pipes placed about 300ft. apart. The toe draining pipe is 24in. in diameter, and the outfall pipes are 36in. in diameter and have a slope of 1 : 1000. Each outfall pipe at its discharge end has a reinforced concrete headwall at the toe line of the dam. This drainage system functioned during the construction period, and remains as a permanent feature of the dam. The core pool drains, however, were not retained except where required as permanent inspection wells, but were plugged with approved fill after they had served their construction purpose. The hydraulic core of the dam rises to El. 3280, and has a maximum height of 152ft. and a base spread of 112ft. Its top width is about 10ft. Above El. 3280 the core is topped to the road level by a prismatic compacted fill on which will be laid a bituminous-paved roadway, 24ft. wide. The roadway is flanked on the upstream side by a reinforced concrete wave wall and on the downstream side by a reinforced concrete guard.

Sand gravel hydraulic fill for the shell of the dam was obtained from borrow areas in the river bed, immediately upstream and downstream of the toe dykes, and the excavated material was delivered to the dam site by two electrically operated floating dredges, and each was equipped with a motor-driven cutting head. One dredger worked from the upstream and the other dredger from the downstream side of the dam. Each dredger carried a 30in. centrifugal pump driven by a 5000 H.P. induction motor, and the pumped material was delivered to one of the two 30in. pipe lines that discharged on to a slope of the core pool beach. The pumping capacity of each dredger was originally in excess of 2000 cubic yards per hour at the lower lifts and averaged throughout the work about 1500 cubic yards per hour. Where booster pumps were used they were driven by 2500 H.P. motors. The pump boat stationed in the core pool carried two 18in. centrifugal pumps, also electrically driven. One of these pumps took water from the core pool and pumped it up to a hog box, in which was dumped loess from borrow pits south of the dam. The hog box on the bluff near the dam discharged the loess and water to slurry pumps directly underneath, which, in turn, sent the slurry through a pipe line leading to the pump boat in the core pool, and a booster pump there transmitted the

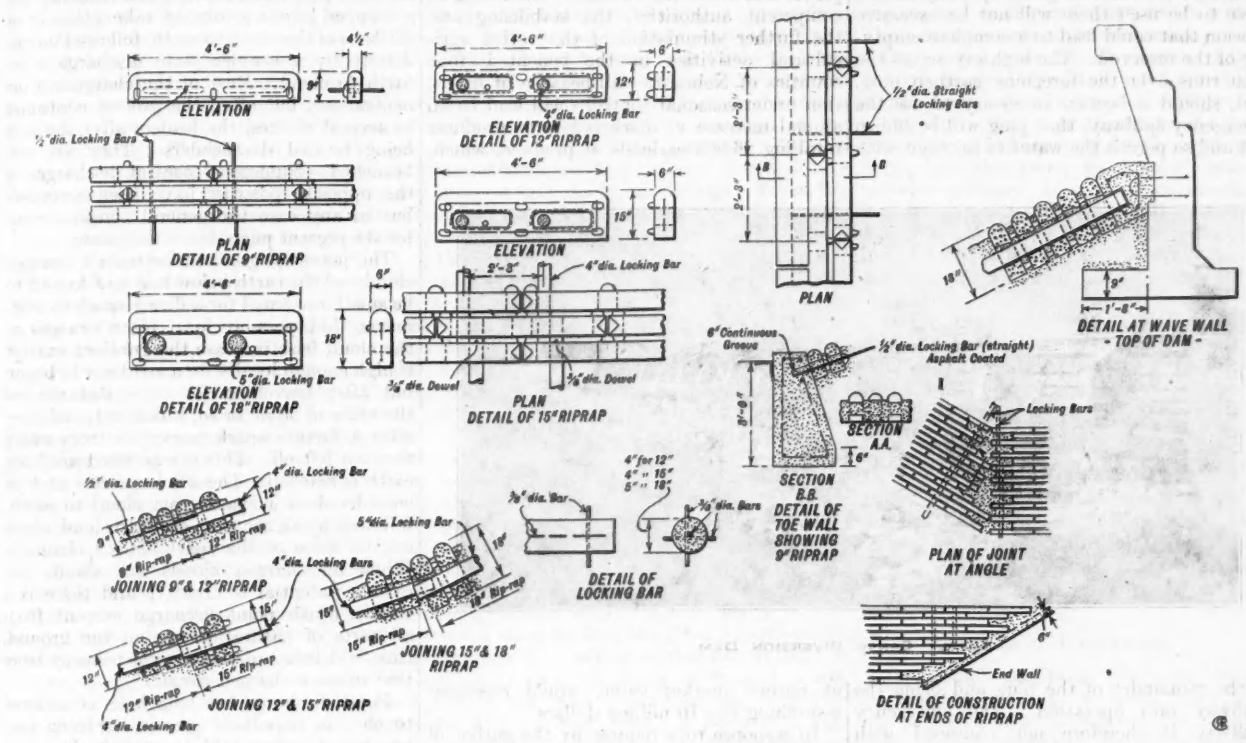


TYPICAL CROSS-SECTION OF DAM

slurry through a central pipe line to any desired point or points along the axis of the core pool. In this manner loess was added in the required measure to the fines from the river bed to upbuild the impervious core of the dam. The placing of hydraulic fill for the Kingsley dam was started early in the summer of 1939, and the last of the fill was pumped into place on December 9th, 1940. Because of the severity of the winter of 1939–40 dredging operations were halted for eighty-three days. The actual working time

templated, as pointed out to the writer by Mr. George E. Johnson, chief engineer and general manager: "This riprap is interesting in that it is a new development of the engineering staff of this District, and consists of concrete blocks interlocked and laced together with steel reinforcing bars. Due to the distance to rock quarries, we found that these concrete blocks could be manufactured and placed at a lower cost than rock for riprap shipped from Wyoming." Accompanying drawings make clear the principal

weigh from 150 lb. to 374 lb., and the blocks were manufactured agreeably to carefully developed specifications, the result of experiments and tests made at the District's own laboratories at Ogallala, Nebraska, and not far from the dam site. The precast riprap is required for 450,000 square yards of the upstream surface of the dam, and the contract price for the riprap, awarded in March of 1939, was 1,011,015 dollars. The present intention is to protect the downstream slope of the dam by planting rye, clover, or broom



DETAILS OF CONCRETE RIPRAP FOR UPSTREAM SLOPE OF DAM

during the placing of the hydraulic fill was fifteen months.

The dyke section of the dam, which carries the barrier northward for a mile farther, has a maximum height of 60ft. and diminishes thence toward its outer end to a shallow roadway embankment. The dyke has a mechanically compacted core of pyramidal shape, in cross section, above ground, which rests upon a reverse section set in a trench with sloping sides, excavated in the underlying ground. The upstream and the downstream slopes of the dyke section are of river sand gravel. The upstream slope has, in principle, a toe drain system akin to that of the downstream slope of the main body of the dam. The 24in. drain pipe is of galvanised metal, perforated along the lower half of its circumference, and with the invert paved. The drain pipe delivers to 18in. run-off piping that carries seepage away to the downstream borrow area in the river bed.

RIPRAP FOR UPSTREAM SLOPE

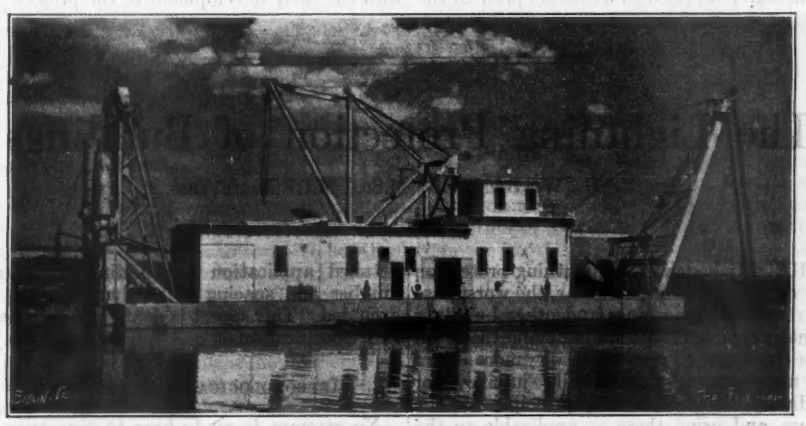
According to the original plans, the Kingsley dam was to have its upstream slope covered with rock riprap from a bottom line at El. 3163 up to the contact point with the reinforced concrete wall at El. 3289·75. This riprap was to extend throughout the main body of the dam and a considerable part of the adjoining dyke section. The riprap was to be laid on a 24in. blanket of selected gravel covering the pumped fill of the slope. The riprap now on the dam is totally different from that originally con-

features of the unit reinforced concrete block and show how the blocks are assembled and bound together so as to produce a protective covering against wave action and floating ice, while retaining sufficient flexibility as a blanket to conform to any movements of the slope of the dam during settlement. It was essential that the riprap should afford free drainage for the underlying fill with any drop of the reservoir level.

The blocks are graduated in their sizes from the top of the slope to the bottom of the slope, where anchorage is made with a reinforced concrete toe wall. The unit blocks

grass. Should this planting prove inadequate after trial, then other methods will be taken to guard against erosion.

In constructing the dyke section, the shell material forming the major portion of the dyke was first stock piled on each side of the dyke by hydraulic methods, and the remainder was hauled in. The core of the dyke is of compacted fill, and the shell was placed against that core by draglines and bulldozers. The estimated final construction cost of the Kingsley dam, including the control structures and the emergency spillway, is put at 14,173,000 dollars. The final



DREDGE FOR PLACING HYDRAULIC FILL

right-of-way cost for the dam and the reservoir basin will be 2,883,000 dollars.

The emergency spillway — previously referred to in this article—is different from the usual types of such spillways. It consists of a channel lying principally in the clay-like impervious brule, with an earthen plug and a concrete overflow section. In practice it is expected that this emergency spillway will never have to be used. The concrete spillway section is built to normal water elevation and is provided merely to ensure that if the emergency spillway should have to be used there will not be excessive erosion that could lead to a complete emptying of the reservoir. The highway across the dam runs over the foregoing earthen plug, and, should it become necessary to use the emergency spillway, that plug will be blown out and so permit the water to take out with it the remainder of the plug and bring the spillway into operation. The emergency spillway is therefore not equipped with gates.

SUPPLY CANAL DIVERSION DAM

The middle diversion dam, an integral feature of the whole project, was constructed several years ago, and then built for the purpose of making direct flow of water available in seasoning the irrigation system prior to completion of the supply canal. It was built primarily as a temporary structure and was not expected to become an important part in the final operation of the project. It is being maintained, however, as an emergency means by which to bring water into the irrigation system should service by the supply canal be interrupted for a protracted period. The construction of the middle diversion dam has paid for itself because it has enabled the Central Nebraska Public Power and Irrigation District to collect irrigation revenue from water supplied to irrigators prior to the completion of the supply canal. The present system has made available water to irrigators during the past three years. In 1941 water was furnished to approximately 40,000 acres, and this year it is expected that 65,000 acres will be served.

The building of the Kingsley dam and the flooding of the associate basin has necessitated the relocation of about 33 miles of an important branch of the Union Pacific Railway, not to mention the shifting of county and State roads, pipe lines, and telephone and transmission lines. According to competent authorities, the stabilising and the further stimulation of the varied agricultural activities in the benefited four counties of Nebraska—all because of irrigation under seasonal control—will lead to an annual increase in marketed farm products totalling 26,905 carloads of produce, which, at normal market value, would represent something like 10 million dollars.

In response to a request by the author of this article for a list of those most responsible for the Central Nebraska Project, the following list has been furnished:—George E. Johnson, chief engineer and general manager; R. O. Green, assistant chief engineer and general manager; George N. Carter, resident engineer; D. A. Buzzell, chief designer; E. E. Chilberg, chief electrical engineer; and W. J. Turnbull, chief soils engineer. The design and construction of the dam was closely supervised by a consulting board made up of H. S. Hunt, president of the Fargo Engineering Company; William Creager; and Joel D. Juston—three outstanding authorities in the United States on the construction of earthen dams. The dam is named after George P. Kingsley, of Minden, Nebraska, who was intimately connected with the early development of the project.

The Lightning Protection of Buildings

By E. H. W. BANNER, M.Sc., M.I.E.E., F. Inst. P.

No. I

THIS article deals with lightning protection of buildings; in particular, the worst case of danger to magazines and other buildings containing explosive or inflammable material. The necessary protection is more than is necessary or economically justified for ordinary buildings, but the principles are the same, and using these as applicable to the worst case, others may be interpolated. The detailed application to buildings, such as number and spacing of conductors, &c., is excluded. This aspect is dealt with in a new B.S. Specification.

METEOROLOGICAL AND PHYSICAL

No attempt is made here to give even a brief survey of the whole subject, but some aspects of the phenomena are necessary for a consideration of the possibility of prevention of lightning discharges. Due to some form of meteorological action, under suitable conditions clouds acquire electric charges; generally it is found that a cloud becomes negative around its base and positive around its upper region. This charging is cumulative until either spark-over takes place or the cloud moves away from a given region, when danger of local discharge passes. With cloud charging as above, the earth below the cloud becomes positive, and there is a tendency for a stepped-leader stroke to take place from the base of the cloud to earth, followed immediately by a heavier main discharge from earth to cloud. Most of the charge is thus neutralised, but often the process continues in several strokes, the leaders after the first being termed dart-leaders. They are unbranched. Numerous cases of discharges of the opposite polarity have been recorded, but in any case the general considerations for the present purpose are the same.

The potential gradient between a charged cloud and the earth below it is now known to be small, too small for a direct spark to commence, but possibly local protuberances at the cloud base increase the gradient until it is high enough locally for a streamer to begin, but after travelling for some distance, of the order of 50 m. or so, it dies out, and soon after a further spark carries on from where the first left off. This is continued until the earth is reached. The whole process may be considered as a spark from cloud to earth, followed by an arc from earth to cloud, along one or more of the spark-ionised channels. When no charged clouds are about, the earth's potential is negative and there is a steady brush point-discharge current from all sorts of natural points on the ground, this field being of the reverse polarity from that under a charged cloud.

Point discharge has long been considered to play an important part in lightning protection, it being held that such discharge tended to neutralise an opposing charge, and so prevent flashover. Recent tests and theory have put this conception into disrepute, and it will be considered more fully. Tests made with an elevated point and a bunch of four points in parallel at the same height, on various occasions in disturbed weather, showed that the current was actually less with four points than with one. Other tests showed that above an isolated charged point is a cloud of ions extending for about 1ft. Consequently, further points in the same region do not increase the current, as measured when corona sets in. To be effective, such additional points should therefore be at a distance from adjacent points of several feet, or a distance of the order of that of the points above the surface being protected. This still leaves open the question of whether point discharge current is a preventive, which will be considered shortly.

For an average potential gradient near the earth of 100 volts per metre the field strength is about 3×10^{-4} e.s. unit per square centimetre, and the current density about 2×10^{-16} ampere per square centimetre. Compared with the above average values, the current due to point discharge from a single tree may be of the same order as that from a square kilometre of average ground. B. F. J. Schonland measured the current from a tree dug up and insulated from the earth and found it to be of the order of 4·5 μA under fine-weather conditions. Based on these figures, Sir G. Simpson estimated the current over the whole world as about 1000 A, and of such a sign as to make the earth negative. This corresponds to a

current density of 2×10^{-16} A per square centimetre, as before.

Data

Lightning data of direct interest involve mainly the peak value of the current in a stroke and the rate of change of current, and to a less extent the number of strokes likely to be involved, the peak voltage and the quantity and energy in a complete flash. The usual average order of current in a stroke is about 20–30 kA, but currents up to 200 kA have been measured; 200 kA is therefore the figure considered, as protection has to consider the worst case. The highest rate of change of current measured is about 40 kA per μ second, but it is likely that greater changes are involved, and so for calculations a rate of 100 kA per μ second has been taken. The number of strokes per flash, n, varies from 1, the commonest case found, to as many as 40, but this latter figure is unusual; 3 is the average figure. In all cases the first is found to be the greatest as regards current and energy.

The voltage between cloud and ground has been estimated to have various values up to as high as 1 kMV, but is now considered to be much lower, and about 50 MV, according to Bruce and Golde. The voltage across the return stroke is still lower, as the channel is then ionised and a fairly good conductor, leading to a lower impedance. Further, it is likely that the greater the current the lower the impedance. The quantity in a flash varies with the current and time, and has an average value of about 30 coulombs, with a value for the energy of about 250 kWh as an average, but with limits of about 100 kWh to 2000 kWh.

The wave form of the current in a stroke is approximately exponential, with a wave front lasting for about 5 μ seconds, and a tail extending the total time to about 50 μ seconds or longer (t). For a multiple flash of several strokes, the total time may aggregate about 1 second, of which the total discharge time will be about 1 millisecond ($T = n\,t$).

Effects and Injuries

A discharge of the order of 100–2000 kWh is likely to cause damage in the event of a direct stroke to anything other than a well-designed conductor suitably disposed to intercept it and to convey it to earth. The current in the main return stroke is the cause of the heating and electro-magnetic effects, and the steepness of the wave front determines the induced effects in the conductor concerned, and also in nearby conductors. The current effects are chiefly the igniting and fusing potentialities, as even the short time involved is sufficient for small conductors to be fused. The electro-magnetic effect is a pinch effect, tending to contract the elements of a conductor to a smaller section. In the case of solid conductors, this is usually negligible, but hollow conductors may be affected by it, if thin-walled. The effect of a direct discharge on imperfect conductors, such as trees, is a blasting effect, the whole tree often being shattered, probably due to the sudden expansion of the moisture which is rapidly vaporised.

The most serious effect likely to be produced by the induced voltage across a conductor carrying a lightning discharge is a flashover to adjacent objects which are nominally at earth potential, and the desirability of low overall resistance and impedance of a lightning conductor circuit will be agreed.

Injuries caused by lighting vary from slight physical shock to fatality. The latter is generally the case if the main discharge passes through the body; lesser effects are the result of proximity to, but not direct contact with, the main discharge. Considering that the current is perhaps hundreds of thousands of amperes, and the energy from a hundred to a few thousand kilowatt-hours, it is hardly likely that serious damage will not occur to a person struck. Burns are the common result, physically, and shock, leading to stoppage of the heart and/or respiratory system, physiologically. Treatment for the latter is primarily persistent artificial respiration. Animals in fields are occasionally killed wholesale, in cases where it is unlikely that all have received a direct stroke. In such cases it is likely that the potential gradient in the earth around the point struck was high enough to cause sufficient voltage between the legs of the animals to pass lethal current. Animals cannot withstand the application of a voltage which is safe for human beings. When the body is struck and burned it is frequently seen that a tree-like burn has occurred. This gives rise to the common newspaper fallacy that "it was a photograph of the tree under which he stood." Actually, it is, of course, an unsymmetrical Lichtenberg figure, the lack of circular symmetry being due to the direct path to earth being more in one direction than equally around the point struck.

Prevention

Can a lightning stroke be prevented from occurring? It is the author's considered opinion that the answer is definitely, No; but that a discharge can be "transferred" or taken on a conductor system and usually discharged to earth harmlessly. This ignores the generally impracticable case of a conductor reaching from the ground to the cloud, although this may be carried out in the case of captive balloons flying in charged clouds, and in the case of some of the very high buildings in New York. A point at a high potential with respect to the surrounding air is the seat of a brush discharge which may be visible even in daytime, and it was considered by early observers that such a brush discharge would "neutralise" a charged cloud and so prevent a lightning discharge from occurring. It was also the idea that several points would be more useful than one, and so the present commonly used multi-point lightning conductor was evolved, using four points projecting upwards and outwards, and a central, higher, blunt rod to take the actual discharge if one did occur. Little evidence has been published on this question, but the Bureau of Standards (U.S.A.) states that "the sole purpose of lightning rods or grounded metal roofs is to protect a building in case a stroke occurs, there being no evidence or good reason for believing that any form of protection can prevent a stroke." An earlier part of this article deals briefly with the physics of the lightning discharge, and provides data and information of use in the design of lightning conductors, and it is shown that a thunder-cloud acquires an increasing charge which is only dissipated by a discharge either to another cloud or to earth.

The energy involved is from 100–2000 kWh, and brush discharge currents, although continuous, are only of the order of micro-amperes. It is difficult to conceive how such a small discharge current could reduce the charge of a cloud and prevent it from flashing over. It is most unlikely that a projection on the earth extending for a small proportion of the distance to the cloud should have much effect on the discharge until it is within a short distance of it. A forest, with myriads of points, is frequently struck, so that on that account also the preventive action is unlikely.

Considering spark formation and propagation, it has been shown, especially by Allibone, that positive streamers rise from points on a plane to meet the negative leader streamers, and the latter diverge to meet these streamers, finally reaching earth through one or more of them. It has frequently been observed that when a discharge has reached a lightning conductor the place struck is not always the uppermost part or point, but some distance down the rod.

To summarise, the author concludes that a stroke cannot be prevented by brush discharge, and so the multiple point is useless. There may be some slight advantage in using a single sharp point, but its effective range is so little more than that of a blunt rod that it has no merit. There is a further consideration. Where a discharge strikes a conductor it is frequently found that a local fusing has taken place, leaving a globular or rounded surface. If a point be employed and it is actually struck, it will then be no longer a point, and so may be eliminated initially by providing a blunt point. But the actual configuration is not of much importance.

One method of protection which has been advocated is the use of a radio-active cell at the top, and it would appear that the use of such a device on a conductor external to a building to be protected would increase the apparent protective radius, and so be of value, but its use on a conductor attached to a building would probably merely start the discharge a little earlier, due to the increased ionisation providing a greater range of positive, earth, streamers. But in either case its effective range of action is so small as to be negligible. It has no real preventive effect.

Ground Conditions

Do ground conditions affect the liability to lightning stroke? As usual, there is no one answer, but most of the real evidence is that ground conditions do affect liability, but probably only locally. Examination of places struck by lightning over a whole continent shows that no considerable area is immune. B. J. Goodlet has summarised the information, and states that ground has an effect, mainly indirectly through the altered meteorological conditions, and locally by increased lightning risk over conducting areas. Generally, high-resistivity ground is less likely to be struck, but rocky ground with metallic veins is more liable to be struck, although an alternative explanation for this fact is the increased air ionisation resulting from the metallic seams. Laboratory tests on this aspect lead to the conclusion that any source of brush discharge, such as metallic objects on the ground, will attract the final flash, but these tests are most unsatisfactory, as the scale is far too small. Further, the air is in practice dust-laden and far from homogeneous.

Protection: General

The general requirements for a building to be protected from damage by lightning are to convey any discharge directly to earth without sparks between conducting material, either on the building or the contents, or by induction in nearby metal, and also without damage to the conductor system, so as to enable it to function indefinitely. A complete metal building would be immune from lightning danger provided that the metal were sufficiently substantial not to be destroyed by a stroke. In practice, all buildings are at least partially earthed, and a high voltage may be developed between a building and the earth; consequently, all buildings should be earthed. All-metal buildings are not

general, except for very small buildings such as Nissen huts, and a more or less skeleton arrangement is usual. Non-metallic buildings for explosives are not now uncommon, and it is generally better to omit discontinuous metal components from a building, if possible, and to replace them by insulating material, such as corrugated asbestos roofing, gutters, &c. In this way buildings may vary from all metal to no metal, and require different treatment accordingly.

On a stroke reaching the conductors of a building the voltage of the system is momentarily raised from earth by an amount proportional to both the resistance component R I and the inductive component $L\,dI/dT$, where R and L are the resistance and inductance respectively of the whole conductor circuit. The need for low resistance and low inductance, by avoiding loops and sharp bends, will be seen. It is necessary that there should not be any great difference of potential between any parts of a building and earth, showing the need for efficient bonding for low resistance and good lay-out for low inductance, and the avoidance of independent earths, at least for magazines.

With any conductor system one requirement is that with the discharge to earth of a quantity Q occurring in a short time T the voltage across the system should be a minimum. High voltages are caused by (1) the current passing through the total resistance of the circuit, including the earth, and (2) the steep wave front meeting an inductance. The relevance of these latter points will now be discussed.

Circuit Arrangements

If a stroke occurs, what is the necessary geometrical disposition of the lightning conductor circuit to minimise danger to the building protected? The simplest case, protection of a very small area of ground, is most readily dealt with by the erection of a vertical conductor, having its upper end at a height not less than that given by a formula quoted later and having contact with earth at its foot. For the present, an earth termination will be taken to mean one that satisfies certain conditions not yet specified. The protection of a larger area will obviously need a conductor system higher than that for the first case, and at an early stage it is obvious that a change from a single vertical conductor to two or more will be more practicable, as well as providing better protection. The ground area protected by a vertical conductor has now become generally accepted as meaning that the area protected has a radius equal to the height of the conductor, while the zone protected is enclosed in a cone of base radius as above. From this it will be seen that for any but buildings of small ground area and low elevation a single conductor would be impracticably high.

Many workers have claimed that the ground radius protected is equal to as much as five times the height of the conductor, but this is now accepted to apply only to each of a number of nearby conductors, and for this case it is certain that the protected radius is more than once the height, and probably a factor of 2 can be relied upon. If the latter figure be taken, it will be seen that the horizontal separation may be four times the height of a number of conducting masts. Considering this protected area in more detail, some workers have assumed that with a cloud at a given height the spark channel will be the shortest path to earth, but this is not borne out by the present theories of lightning propagation which show the stepped leader formation where objects on the earth have no noticeable effect until the stroke tip is near the earth or earthed object. The stepped leader stroke determines the direction of the branches, and each step comprises a short streamer about 50 m. long, such streamers leading off in the general direction of earth, but until near the earth they are controlled by the space charge in the air, the local air conductivity and the higher voltage gradient just below the leading tip. Therefore it is not logical to take account of the cloud height, but only of the position of the leader tip at any instant. Laboratory tests are unfortunately of little value, as the distances are so small in relation to those in Nature that deductions based on such tests are incorrect. It has been suggested by Slepian that for scale tests to be useful all factors should be reduced in proportion, including the mean free path of the electrons in the gap.

Whilst in practice protection carried on the building is usual, for maximum protection the removal of such conductors away from contact with the building is desirable. An extension of the scheme of remote conductors is in the provision of conductors suspended between the masts and over the building. The masts may then be of lower height and the spacing of the wires and the height above the building compromised so that all parts of the building are protected by conductors satisfying the rules given earlier. It is recommended by the Bureau of Standards (U.S.A.), in its recommendations for steel and other tanks containing inflammable gases and liquids, that the conductors should be distant from the tank by not less than half their height.

It will be realised that the closer the lightning conductor system is to the building framework and to the contents, the greater is the danger of induced current in the framework and in conducting contents. Consequently, for the usual case of conductors erected on buildings, more care is necessary in reducing R and L than is necessary when the conductors are remote. For the case of remote conductors having no connection with the building, other than a common earth, the momentary voltage may be higher without necessarily causing danger to the building protected. For this reason, remote conductors are to be preferred, where they can be used, on æsthetic or other grounds. Two considerations determine the minimum distance of a conducting mast from the building. These are (1) resistance drop and (2) inductive drop. The assumed maximum lightning current is 200 kA. Now the spark-over value of a long rod gap, intermediate between a point gap and a sphere gap, is about 200 kV per foot. Consequently, for spark-over not to take place the distance should be not less than 1ft. per ohm of earth resistance, a current of 200 kA in 1 ohm developing 200 kV. The inductive drop is based on $E = -L\,dI/dT$. Measurements on towers for overhead lines show inductance values of the order of 20 μ H for a tower of 100ft., and using the same value of dI/dT, the product E per foot $= \frac{20\times10^6}{100}\times\frac{100\times10^3}{10^6}$. The units are volts, henrys, amperes, and seconds. From this E=20 kV per foot, and, again considering a rod gap with a spark-over value of 200 kV per foot, a rule is evolved giving the minimum distance as one-tenth the height of the building. The worst of these two results should be that chosen.

Earthing Considerations

Whilst a conductor system of low resistance is easy to attain, what should be the earthing arrangements—disposition and resistance? Of two otherwise similar earth systems, the lower resistance one is obviously better for any purpose, but as lightning is a transient, the impedance is not the same as the resistance, but may be distinctly lower. It is probable that dielectric rigidity is as important as resistance, and experiments have shown that the behaviour of sand and that of water are not unlike under high voltage impulses, leading to the extreme consideration that a given disposition of earth electrodes is satisfactory for all earth resistivities. On the other hand, the usual plan is to maintain a constant resistance, increasing the number of electrodes as the ground resistivity increases.

It has been shown by Bellaschi and in more detail by Davis and Johnson at the N.P.L., that under a high-voltage heavy current impulse the impedance may vary from equality with the ohmic resistance down to half this value. When the current is small, and particularly when the earth resistance also is small, the phenomenon is one of conduction, but at high current densities, and particularly when the earth resistance also is high, the phenomenon changes to a dielectric breakdown effect. Sparks have actually been seen to occur under these conditions, and one obvious criterion for satisfactory earthing is that no sparking should be possible. The tests also showed that breakdown commenced when the current density at the surface of the earth electrode reached about 3·3 A per square centimetre for the soil used. This is reached with a voltage gradient of the order of 5–20 kV per centimetre, according to the ground. Now the surface area of earth rods for this current density in average clay having a resistivity of 3 k Ω per square centimetre and a current of 200 kA would require about forty electrodes, each ½in. diameter and 12ft. long, and would have to be so disposed that all were effective. Such an earthing arrangement is in general impracticable, except in extensive sites where many buildings are close together.

It has already been shown that the lower the conductor resistance, and the more complete the bonding of the whole of the conductors and conducting parts of the building, the less is the need for a low resistance earth system.

Remote conductor masts, being usually further from any explosive material than are conductors on a building, have less need for a low earthing resistance as a high momentary voltage attained during a stroke is of less consequence. The conclusion reached is that no one figure for earthing resistance can be given which will apply to all cases and which can be shown to have a scientific basis.

A building should have a minimum of two down conductors and two earth connections. These should be electrically in parallel, usually by means of a base conductor surrounding the building. Consequently, the larger the building, the larger the quantity of earth electrodes available for earthing, which is desirable. All electrodes within about 100 yards may be considered as effectively in parallel for a lightning stroke.

A practical proposition is to commence with a value of resistance found satisfactory in the past, and to use this as a basis figure for general cases, modifying it where necessary, such as in high-resistivity ground, under the general considerations given here. A value of 10 ohms has been found satisfactory in practice over many years, but in order to allow for seasonal variations a working figure of 7 ohms is proposed, allowing about 50 per cent. for deterioration for seasonal causes. The value of 7 ohms is easily attained in low-resistivity ground for a building having many earth electrodes,

but in order to be certain that all are effective, and to avert the contingency that short rods may be in very dry ground in the summer, a minimum of 12ft. of ½in. electrode is recommended at each earth connection. This reduces the current density at each point, which is desirable, even when the combined resistance is quite low.

The potential gradient around an earth electrode during a stroke will vary with the earth resistivity, and may be high enough to cause breakdown, as has been shown; consequently, it is desirable that electrodes should not be driven too close to buildings. On the other hand, a vertical run of conductor from air electrode to earth is desirable, to minimise rise of voltage due to inductance of loops and bends in the conductor. A mean of these two courses has to be followed, and a recommendation is made that a distance of 12ft., or the electrode length, should be the spacing between earth electrodes and buildings. In the case of very high-resistivity ground, this will require to be increased, but special consideration is then required.

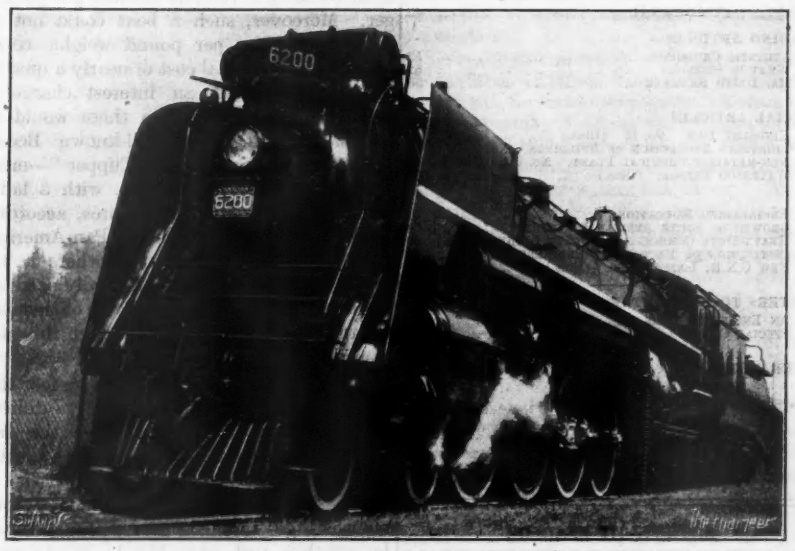
The reduction of earthing resistance, in the case of a site of a number of adjacent buildings, is usually simply carried out to almost any extent by the interconnection of the earthing systems of various buildings, forming one large network. The network may be already provided in the form of water mains, and if these are large iron pipes of not less than about 4in. diameter, laid as a network, such as for fire-fighting purposes, such a network may be used to aid the electrode network or even to supplant it, particularly where the earth resistivity is high or the water main system is extensive and has a low measured resistance. Whilst the use of water mains for earthing is possible for Government magazine areas, it may not be permissible for ordinary sites, on account of restrictions on earthing to water mains.

With remote conductors, if these are sufficiently remote from a building, and situated in low-resistivity ground, each earth electrode system may be self-contained. But in other cases, and it may be advisable in all cases, the earth electrodes of all remote conductors serving one building, or even of all those in the area, should be interconnected, preferably by a buried conductor network. In this way the network of earth conductors surrounds the whole of the danger building area, and tends to keep all current flow outside the perimeter, and so away from all foundations and walls, the ideal condition to be aimed at. Where such masts have individual earth electrodes, these should be 12ft. rods, or more than one, in high-resistivity ground, but in this case the higher resistance may be permissible owing to the distance between the mast and the building and its contents. The rules guiding this distance have already been considered.

(To be continued)

New C.N.R. Locomotives

IN the accompanying engraving we illustrate the first of a series of thirty-five locomotives being manufactured for the Canadian National Railways by the Montreal Locomotive Works, Ltd. These engines are being built under the direct supervision of Mr. John Roberts, C.N.R. Chief of Motive Power and Car Equipment, and are urgently required to haul the increased traffic arising from war conditions. They are of the 4–8–4 type and are an up-to-date edition of the Northern type that has given satisfactory service for several years. Among the new features are an improved spring arrangement, the inclusion of a new type of superheater and the streamlining of all steam passages from the boiler to the cylinders, for the purpose of lowering the resistance to the flow of the steam. It is calculated that these locomotives will haul 1000 gross ton miles for an expenditure of 42 lb. of coal. The principal data are:—Cylinders, 25½in. by 30in.; driving wheels, 73in. diameter; boiler pressure, 250 lb. per square inch; tractive effort, 57,000 lb.; total length of engine and tender, 94ft. 4in.; tender capacity, 11,600 gallons of water, 18 tons of coal.



NEW 4-8-4 LOCOMOTIVE FOR C.N.R.

As soon as further locomotives are received they will be placed in fast freight and passenger service on the Central Region of the Canadian National Railways.

American Engineering News

Aluminium Hydro-electric Scheme

In planning greatly increased production of aluminium for war purposes, two large dams are being built in the eastern part of the United States to develop hydro-electric power. In both cases a high head is developed by means of long pressure tunnels, with an annual output of 250 million kilowatt-hours in one case and 125 million in the other. The Glenville dam, in North Carolina, 900ft. long and 150ft. high, has a volume of over a million cubic yards of earth, faced with rock on both sides. During its construction the river was diverted through a 9ft. tunnel, 850ft. long, which is fitted with two gates for control of the water level in the reservoir. The spillway or waste weir radial gates are supplemented by what are termed fuse-plug dams, which are intended to wash out or blow out if overtopped by a sudden rise of water level due to mountain storms. These small dams are 20ft. long between the piers of the bridge across the spillway, and are designed to fail successively, being 2ft., 3ft. and 4ft. high above normal high water. To prevent erosion by rainfall they are faced with loose rock. From the reservoir a 12ft. tunnel extends 3700ft., with a fall of 37ft. to an 8ft. steel penstock which drops 387ft. to a second tunnel, 4600ft. long, having a fall of 15ft. to a second penstock. This has a drop of 330ft. to the third tunnel, 4800ft., having a fall of 35ft. From it a third penstock, 6ft. in diameter, drops 320ft. to the power-house, below which is an 80ft. drop to the tail-race. From reservoir level to tail-race the fall is about 1210ft., and the working head on the impulse turbines 1150ft. The turbine has two wheels, one on each side of the generator, and the water passing through a 10in. needle valve strikes the buckets of the wheels at a speed of 280ft. per second. The horizontal shaft generator produces power at 6600 volts, which is stepped up to 154,000 volts for the transmission line to the aluminium works.

Foundry Bessemer Converters

To increase the production capacity of steel castings, as needed now for tanks, guns, ships and other war material, some steel foundries in the United States are using side-blow Bessemer converters, which have been introduced largely since 1940. The reasons are mainly: first, the development of a practical means of reducing the sulphur content in the cupola metal; and secondly, the development of electric eye apparatus to aid the converter operator in accurate control of the operation. In earlier use of the converter a difficulty was inability to reduce the sulphur content in the cupola charge, necessitating the use of low-sulphur pig iron and scrap to keep the sulphur within the permissible limit in the finished product. With desulphurising of the cupola metal by treatment with alkalis in a receiving ladle it is now possible to hold the sulphur to a maximum of 0·03 per cent. in the finished steel. This again permits a wider range of raw materials in the charge, the proportions of pig and scrap being varied according to cost and availability. In fact, the charge may be nearly all steel scrap, but with a silica-bearing alloy to give the required percentage of silicon in the cupola metal. With the electric eye apparatus, also, it is not necessary to depend upon the operator's eye, and the end point of the blow can be determined to a split second. Carbon, silicon and manganese have then been eliminated, and are to be replaced in desired amount by ferro-manganese and ferro-silicon in the cupola metal; also about a pound of aluminium per ton of steel. Since there is no reliable method of reducing the phosphorus, this must not exceed 0·04 per cent. in the charge. However, experiments are being made by treating the Bessemer steel in the ladle with certain chemicals. Steel castings for ordnance keep within the limits of chemical composition and show 75,000 lb. to 80,000 lb. tensile strength, 42,000 lb. to 48,000 lb. yield point, 25 to 30 per cent. elongation in 2in., with 42 to 52 per cent. reduction of area, and 140 deg. to 180 deg. in cold bending. Converters are being introduced also in grey iron and malleable iron foundries.

MONEY FROM METERS.—The use of what are known as parking meters is growing in the U.S.A; 125 cities installed parking meters in their "heavy parking" districts during 1941 and the first month of 1942, increasing the total number of municipalities using meters to 350. The majority of these meters require a nickel coin, but an increasing number of cities—especially small ones—is installing penny meters, and the latest survey reports 88 cities as using penny meters.

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Contents

THE ENGINEER, July 17th, 1942. PAGE

A SEVEN-DAY JOURNAL ... 43

LEADING ARTICLES—
ATLANTIC CROSSINGS ... 52
WHAT IS SCIENCE? ... 52
MR. DAVID BREMNER ... 53

SPECIAL ARTICLES—
KINGSLEY DAM. No. II. (Illus.) ... 46
LIGHTNING PROTECTION OF BUILDINGS. No. I ... 48
NON-METALLIC CHEMICAL PLANT. No. III. (Illus.) 44
WATERLOO BRIDGE. (Illus.) ... 55

ENGINEERING EDUCATION ... 57
GROWTH OF SOUTH AFRICAN INDUSTRIES ... 54
HEAVY-DUTY COMBINATION TURRET LATHE. (Illus.) 59
INSTITUTION OF MECHANICAL ENGINEERS ... 60
NEW C.N.R. LOCOMOTIVES. (Illus.) ... 51

LETTERS TO THE EDITOR—
AN ENGINEERS' WAR ... 53
SPECIAL GAUGES ... 54

LITERATURE ... 53

NEWS AND NOTES—
AMERICAN ENGINEERING NEWS ... 51
FORTHCOMING ENGAGEMENTS ... 62
MARKETS, NOTES AND NEWS ... 61
NOTES AND MEMORANDA ... 62
SIXTY YEARS AGO ... 54

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Half-Yearly Index

With the object of conserving paper, the number of copies of the Index to Volume CLXXIII will be limited. Copies will be sent to all Institutions and Public Libraries on our mailing list, and subscribers may obtain copies on application gratis and post free.

ATLANTIC CROSSINGS

THE statement lately made by Mr. F. G. Miles, a well-known aircraft designer, on the subject of future Atlantic passenger services, will have astonished many who read it. He forecast that the cost of carrying passengers by air from London to New York might prove to be as low as £8 or £9 per head, and take no more than twelve hours. This represents an economy of money far beyond anything that most people would have thought likely. It would have been expected that the cost of fuel alone must eat largely into so low a fare. A simple estimate shows that a flying boat of 100 tons weight, carrying, say, 200 passengers, would need for such a crossing some 12,000 gallons of fuel, equivalent by itself to not less than £3 sterling per passenger. Moreover, such a boat could not be built under 20s. per pound weight, corresponding to a capital cost of nearly a quarter of a million, with an interest charge of some £200 a week. Then there would be the wages bill. The well-known Boeing flying boat—the B.314 "Clipper"—much used now for such crossings, with a laden weight of only 40 tons, requires, according to Mr. Trippe, president of Pan-American Airways, a captain and ten others in the crew. Our 200-ton boat can hardly need less and the wages bill must take care of them all. Charges there will be, too, for such things as insurance and maintenance.

Enough has been said to justify a fear that so low a passenger rate may prove difficult of attainment if passengers are the only source of revenue. Perhaps its author may be ready to publish the basis on which his forecast was made. Some months ago there appeared an estimate by another authority, Mr. C. H. Dickens, vice-president of the Canadian Pacific Air Lines, who thought that the cost per ton-mile would probably be 28 cents, corresponding to 225 dollars per passenger. This is a good deal higher than Mr. Miles' estimate, and if one cares to go back five years one can find, in a report to the Engineering Institute of Canada, that the cost per passenger journey was put as high as £100. That report dealt with mails as well as passengers, and it put the first-class mail matter between European and North American ports at 1500 tons a year, or some 30 tons a week. As it is likely that almost, if not quite, the whole of this will in future days be sent by the air route, this will provide a large and welcome source of additional revenue. A passenger fare of as much as £50 comes to but 3d. an ounce, far less than will willingly be paid for air mail. The fact is that passenger revenue is likely to be a subsidiary item, and this may explain the wide differences in the cost estimates which have been made. Some may allow a smaller proportion of air mail to be carried and some more, but the question is one which will spring into importance at once when the war ends.

The flow of aircraft cross the Atlantic in these war days is as impressive in its steadiness as it is heartening. The ferry service by air affords not only the quickest route, but the safest. Much is being learnt of navigation at the altitudes and air speeds of to-day. The navigating officer employs dead-reckoning, celestial observations, or radio bearings. Dead-reckoning is the oldest method of navigation, whether by sea or air, and in a surface ship its measurements are much affected by the known ocean currents. These are quite overshadowed in intensity by the powerful winds that carry aircraft off their courses, but, on the other hand, the atmosphere is commonly clear enough to permit observation of the sea and so permit an estimation of the drift. In wartime, navigation by the sun and stars is especially useful, since radio cannot be fully made use of, but in the days of peace the latter will no doubt prove by far the most effective. Moreover, it may be expected that a considerable addition to the safety and punctuality of air travel will arise from the astounding improvements in position finding made available by the methods only partially revealed hitherto under the title of radio-location. We shall then learn with interest what proportion of the 300,000 Atlantic travellers each year are drawn to prefer the air route. We suspect that it will prove surprisingly large.

What is Science?

WHAT is science? There is no word more frequently in the mouths of our legislators or in the print of our newspapers. But do any two of them mean exactly the same thing by it? There is no perfect definition of it. Broadly, it means knowledge and especially systematised knowledge. But that is too large a cloak for the single word; we need something more particularised. We want a word that will indicate a special form of human endeavour; we want especially a word that will distinguish between technology and science. Technology is not simply applied science unless we use the latter term in its broadest, all-embracing, sense. Trevithick, Murdock and Stephenson were pure technologists. There was no Science—with a capital S—in their make-up. There was little or none in any of the great engineers before Watt, and mighty little in any that followed him up to the middle of the nineteenth century. Even much later technicians did their work with very elementary science—barely worthy of the name. Four outstanding inventions of the last war—the tank, the trench mortar, the Mills bomb, and the paravane—were not invented by scientists. What scientists have done for the present war we do not know, and shall not know until the conflict is over. We are prepared to believe that their contribution has been great. We know with certainty of a few things that stand to their credit—radio-location and the Gauss girdle are salient. But the evidence is that their efforts to counter the submarine or the bomber have had but a limited success. In these respects all the science of Germany, Russia, and this country has not fulfilled the hopes that the public had been led to repose on it.

It will be said that we are using the term "science" in a restricted sense. So we are. We are using it in the sense in which Members of Parliament and men in the street—Fleet Street and Queen Victoria Street especially—use it. The ordinary man makes a sharp distinction between science and technology. Science is something of the laboratory; technology of the workshop. That is a crude distinction, not quite fair to either, but it is current and must pass in lack of something better. The laboratory is an arcana from which wonderful things have come and may come again. The workshop is an ordinary place where men and women just like all other men and women work. There is nothing recondite or mysterious about it. Nearly all its operations are open and above board. It is so commonplace that it does not receive its due. Yet we owe production of war material

far more to technology than to science. It delivers the goods. The crying problems of the day are technological; how to make two tanks grow where one grew before; how to build ships faster; how to increase the rate of output of shells and aeroplanes. These are problems of the drawing-office and the workshop. A committee of scientists will not solve them so well as a committee of mechanical engineers. There are too few engineers in the Royal Society to satisfy the need. The Cabinet must look elsewhere. It must think more of technology than of science. To this day grave mistakes are being perpetuated in our factories; mistakes that are costing time and money and man power. In many cases the manufacturers themselves are not responsible. They see better ways of doing things, but are powerless to get them adopted. A committee of industrial engineers could put many of the faults to rights. It could stop extravagance in design and materials; study design with a view to rapid production; simplify jigs and gauges; cut out precision in unnecessary places; and so forth *ad lib.* A Noah's Ark Council—like the Advisory Council on Scientific Research and Technical Development—with two of all kinds of scientists on it, may be admirable; a Brains Trust of the highest eminence. It has done and is doing wonderful work in certain directions; work that must not be spoken about. But it cannot solve engineering problems. To do that an *ad hoc* council of mechanical engineers—the production of electrical plant is a mechanical engineering job—is needed.

A typical instance of the public attitude towards science is provided by a passage in a leading article in *The Times* of July 9th. In it we read "the man of science is a natural innovator, and this war will be won by innovations or not at all." Clearly, our great contemporary holds that the scales of battle can only be turned by some stupendous new scientific invention. We cannot share that view. The means of winning the war are already in the hands of the Allied Nations. More rapid production is the primary necessity. That is a task for engineers, not for high scientists. Advancement in design to meet ever-changing requirements is also essential, but it must not retard output. Again, we must look primarily to engineers, rather than to science. No new scientific discovery or invention has ever come to fruition overnight. A long period of development is necessary. Months pass in reducing the scientific idea to a practical form; more long months in preparing gauges, jigs and special tools to enable mass production to be effected. Hence, if we have to wait for a scientific innovation to end the war, it will never end. The means of bringing it to a successful conclusion must be sought in the technology of design and manufacture.

Mr. David Bremner

MANY engineers will hear with something approaching consternation that Mr. David Bremner, who is not as young as he looks or his unfailing energy would lead one to believe, has decided to retire from the directorship of the British Engineers' Association. He has held that position for nearly twenty-four years, and under his guidance the influence of the Association has increased year by year till, at the present time, it is recognised as the leading authority on all matters associated with national aspects of industrial engineering. It has attained this position not only by the wise policy of a succession of devoted Presidents, but also through the strong personality of its director. Mr. Bremner is not only an exceptionally clear thinker, but we need not remind those who have heard him speak or those who have read his reports, that he expresses himself with decision and vigour. There are two things in particular that must be mentioned in connection with his directorship. The first is the development of *The B.E.A. Bulletin*, with its invaluable tables and records of current events, and the other the monthly luncheons at which some subject of importance to the engineering industry was presented by accomplished speakers. Both these things are in abeyance owing to the war, but everyone who is acquainted with them will look forward to their revival as soon as possible after the cessation of hostilities. We are quite confident that all engineers, whilst regretting Mr. Bremner's departure from an office he has so long adorned, will respect his desire for relaxation from duties in which he never spared himself, and wish him happiness in such retirement as the Council of the B.E.A. is able to allow him and he is able to accept. We understand that it is the wish of the Council that he shall continue to advise it, and we suspect that after many years of vigorous life and with lots of energy left, Mr. Bremner's leisure is likely to be more nominal than real.

Literature

Principles of Ignition. By J. D. MORGAN. London: Pitman and Sons, Ltd. 1942. Price 12s. 6d.

THE very word ignition—the making of fire—carries one back to the infancy of our race. Primitive man may not have troubled himself much about the principles involved in the igniting of fires, or of the principles of anything else, for he was a practical fellow and the one kind of firing in which he was interested was of an elementary form, too elementary to find exposition in Dr. Morgan's survey. But there is a link between the two, since the first fire that the first man ever saw, though he could not copy it, was lit no doubt by some sudden lightning flash, and it is the mechanism by which such a flash can produce such a result that is the concern of the author. He surveys, in addition, the way in which ignition can equally be caused by incandescent surfaces or by flames, whether in the air accidentally laden with combustible dust or in the intentionally explosive mixtures used in the internal combustion engine. By studying the conditions of ignition in dust-laden air, whether in mines or factories (wood, sugar, starch, flour, or sulphur), it is hoped to eliminate explosions and by the study of ignition in engines to ensure them.

Most engineers, on being faced with a request for an explanation of the way in which the spark ignition of a petrol engine works, would probably suggest that it was a two-stage phenomenon. First, they would say, there is the electric potential created across the spark gap by the ignition system, with the resulting ionisation of the gases lying across the gap. Then as the gases are ionised they gradually become conducting, and an electric discharge begins to take place. They would find it simple to picture the rest of the effect as purely thermal. The current heats up the gas around the gap till it arrives at the point where the growth of heat by gradual combustion exceeds the loss by radiation, conduction, and convection, and thereafter the temperature runs up with a leap, and an explosion results. When physical and chemical conditions chance to be ripe, combustion may spread by adiabatic heating in the rapidly travelling compression wave and so give rise to that intensely vehement form of combustion known as detonation.

This rough-and-ready statement of how the average engineer may look on ignition has, it will be seen, two aspects, an electrical and a thermal. Much of Dr. Morgan's book deals with the rival claims of those who think that electricity is the main factor and those who prefer a thermal theory. Many experiments are described, one of the most impressive being the production of an easily visible electric spark in an explosive medium without any resulting explosion, showing that there has to be a sufficient energy supply coming from the spark itself before ignition takes place. Much is said on the well-discussed question of the relative "incendivity" of the sparks caused by condenser discharge and those due to breaking an inductive circuit; and it is pointed out that, on the basis of the tests described, capacity sparks must be regarded as having a somewhat greater effect than that of inductance sparks dissipating the same amount of energy—although a spark with a large inductance component may remedy defects in the carburetting system by gasifying sufficient vapour in its neighbourhood to help the ignition to occur.

Two-thirds of the book are given to the facts to be accounted for and one-third to the theories that endeavour to do so. The arguments are well set out, though we are not left at the end much wiser as to which line of thought is preferred by the author. It may be that most readers, without making the least claim to have given very full attention to the subject, will feel bold to consider that their own simple ideas on the subject were not far out, and to hope that the day is near in which our mathematical physicists will find themselves able to predict by their expert analysis each and every successive step in the process of ignition, so that in the days to come the best of "sparks" can be designed for us in advance. In the meantime, we have Dr. Morgan's excellent little treatise as our guide.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

AN ENGINEERS' WAR

SIR,—"This," the publicists tell us portentously at intervals, "is an engineers' war." And what war, one retorts, was not. When Shakespeare wrote: "Or, like the engineer, hoist with his own petard," he was clear that the engineer both constructed and operated the engines of war even to his own hurt. This has always been so. The only other example we need quote is that of Vauban, the great French engineer, who was entrusted not only with the defence, but the reduction of many cities, and for his skill and valour was made a Field-Marshal. Although we repeat so often "This is an engineers' war," it is pertinent to inquire whether we do, in fact, believe it, and whether we are allowing the engineer to

exercise the control, initiative, and direction essential to mechanical superiority.

If this is an engineering war, then the Ministry of Supply must be the engineering instrument by which the products of engineering in quality and quantity are supplied to our armed forces. One would assume therefore that on common sense and every other ground, the controller of this huge engineering industry should be an engineer. In fact, with peculiar perversity, we have tried in the post of Minister of Supply and Production men of every profession alien to that of engineering. We have tried lawyers, journalists, and so-called business men. The Minister of Production's ablest and closest assistants are not engineers, but statisticians and economists. There are engineers in plenty in the Ministry of Supply, but each one is tucked in his own nitch in sectionalised departments. The result of having this lay control of a technical organisation is that there is no one at the head of affairs to pull the individual departments together technically, to determine their main lines of development, and how they fit into a common technical scheme. Any expert in any section can lead the non-engineering Minister "up the garden path." He can, for instance, make him say in public, as he did the other day, that bomber aeroplanes lend themselves to mass production, while fighter aeroplanes do not. This is equivalent to saying that 5-ton lorries can be made on mass-production lines, and 8 H.P. cars cannot. Similar manifest absurdities in his speech make most engineers wonder not only what office boy had written out his speech for him, but how he can possibly be expected to do his job.

What is wanted at the Ministry of Supply or the Ministry of Production, whichever is the leading body (if anyone knows), is an engineering organisation with an engineer at the head to see we get the very best mechanical effort put forth in the production of all armaments. If we wish to look for an example, we need only consider what our enemies do. Their Minister of Production was Dr. Todt, one of their most eminent engineers. Now he is dead the work is being carried on by the engineering organisation he created. What is required is not one man with a resounding name, but an engineering organisation, *i.e.*, a body of men working together and working all the time to one common end. They should all be practical engineers of wide technical experience. Let us have no committees that meet once a month; let us have an engineering organisation. Then, and then only, shall we start to rival our enemies in the production of quality and quantity weapons.

Before, however, we can expect to get an engineering organisation working under Government auspices and consisting of the best engineers of the nation, the Treasury will have to recast its ideas about payment. The Treasury regulates the scale of salaries paid to Ministry officials by reference to the peacetime scale, when holidays were longer and the general policy of the Government was to seek cheap service by paying in honours and easement rather than emoluments. In order to avoid raising its wage scales owing to possible post-war difficulties, the Treasury has refused to pay salaries of sufficient size to attract competent people. Most of the good men in the various Ministries have, either at considerable self-sacrifice taken on these jobs, or they have been subsidised by their own firms. Many of the remainder are men of third-rate ability, glad to accept second-rate pay, or are men who have been thrown out of employment through one cause and another. The really first-class brains, the men who are getting £2000 a year and over in industry, simply cannot take up Ministry posts where the remuneration offered is less than half what they are getting in private life, and would not suffice to pay their income tax commitments. Instead, therefore, of a Ministry of Supply with an engineering organisation pulsating with life and seething with new ideas and the keenness to get the best in quality and quantity, we have something very far below this standard. Many of the men in the Ministry are doing a very good job of work, but it would be idle to pretend that the general level of excellence is anything near what it should be.

To sum up:—(1) We should have an engineering organisation of the highest calibre controlling the work of the Ministry of Production, both quantitatively and qualitatively. The Minister of Production should be an engineer. (2) We should have a corps of engineer officers in the field reporting direct on all weapons to the engineers at the Ministry of Production, such field engineers to have the rank and pay proportional to their important duties. (3) There should be an engineer, either civilian or Service, on the higher councils of the war direction.

Although the publicists and politicians tell us with monotonous reiteration that "This is an engineers' war," we do not so far believe it; otherwise we should give the engineers a chance to get on with the job.

W. N. HALLETT.

Bournville, Birmingham, July 10th.

SPECIAL GAUGES

SIR,—We are anxious to discover whether special gauges which would fulfil the following requirements are in existence:—

(1) A gauge which will register the impact blow of a hammer weighing about 900 lb., falling through a distance of 2ft. on to a stationary object. The idea would be to insert the gauge between the hammer and the object struck with a dial fixed at a convenient position nearby to register the blow.

(2) A gauge somewhat similar to the above, but to register the force exerted by a hydraulic jack, the jack in question being of the order of 35 tons, and the gauge again being inserted between the jack and the object to be withdrawn with a suitable calibrated dial fixed nearby to indicate the force exerted.

With regard to (1), as the period of impact would be very short, it would be advantageous to have a gauge with a needle, which would remain constant at the highest point of movement, with a trip gear for resetting purposes, so that the actual reading can be taken after the blow has occurred. This refinement will, of course, not be necessary in the case of (2), as there will be ample time to take the readings while the pressure is being applied.

LONDON ENGINEERS.

Growth of South African Industries

SOUTH AFRICAN factories are to-day turning out millions of pounds' worth of goods more than at any pre-war peak period, and are making an amazing variety of articles. Between September, 1939, and September, 1941, the number of factories increased by 158—at present the number of factories producing in the Union is 8830. Employment in manufacturing industries in July last year was 9 per cent. greater than in July, 1937, which is considerable, taking into account the large numbers of industrial workers who were serving with the Forces. The monthly average of electric current generated by the principal undertakings last year was 42 per cent. higher than in 1937, and 10 per cent. higher than in 1939. Allowing for the increased demand by the mines and railways, the figures point to great industrial expansion.

To serve growing industries, particularly the engineering and metal-working industries, the production has been begun of precision and machine tools, gauges, lathes, and hydraulic presses, hack-saw blades, ball bearings, and insulating tape. South African factories have begun making special upholstery springs and spring units for mattresses and cushions, safes, steel door jambs, hardware, and telegraph instruments. Other new products are cotton drill, hair brushes, plastic buttons, a wide range of clothing and underclothing, hair combs, and cotton waste.

Plant is being erected by private enterprise for the manufacture of tweed cloth. Another plant for making collapsible metal tubes will shortly be in production. Its only handicap will be a shortage of certain metals.

Many types of vegetable extracts previously imported are now being made in the Union. The manufacture of cereal foods has been greatly increased. The South African Iron and Steel Corporation is manufacturing a number of grades of steel formerly imported, notably high-grade tool steel. Eventually, it will produce fencing wire. The farming community is now able to purchase South African built agricultural implements, the manufacture of which is rapidly increasing. A development in the fishing industry is the production of high-grade fish and shark oils, for which there is a growing demand. Biological preparations from the glands of freshly slaughtered animals are being made. The raw materials for both these new industries were formerly regarded as waste, or at best as offal.

A number of chemicals is being produced to-day which are important to the leather industry, such as chrome salts, sodium sulphide, lactic acid, and sulphurated oil. Chlorine and aluminium sulphate for water purification, casein glues, nitro-cellulose finishes and cerecine discs used in food packing are other new products. The industry is contemplating many new developments soon. Union factories are now producing ethyl chloride for anæsthetics, adrenalin, injective liver extracts, and other preparations which used to be imported. The manufacture of producer gas generators for use with internal combustion engines is another new industry which it is believed will grow after the war.

Though this industrial activity will slow down after the war, when purely war production decreases, many of these new developments serving peacetime requirements will continue. If depression and unemployment are to be avoided in the future, the industrial impetus now attained must not be lost. Its continuance depends on energetic exploitation of the Union's adjacent markets, and on the maintenance and increase of spending power in the internal markets, which will be widened from 2,000,000 to 8,000,000 people, with the increase of the purchasing power of the lower-paid workers of all races, and the gradual increase in their agricultural earnings.

The Department of Commerce, it is stated, has been told by a manufacturer of goods hitherto imported that it should be possible to produce goods in South Africa that can compete with those brought thousands of miles by sea. Imported goods are very often manufactured from raw materials sent thousands of miles from their country of origin (often South Africa) to overseas manufacturers.

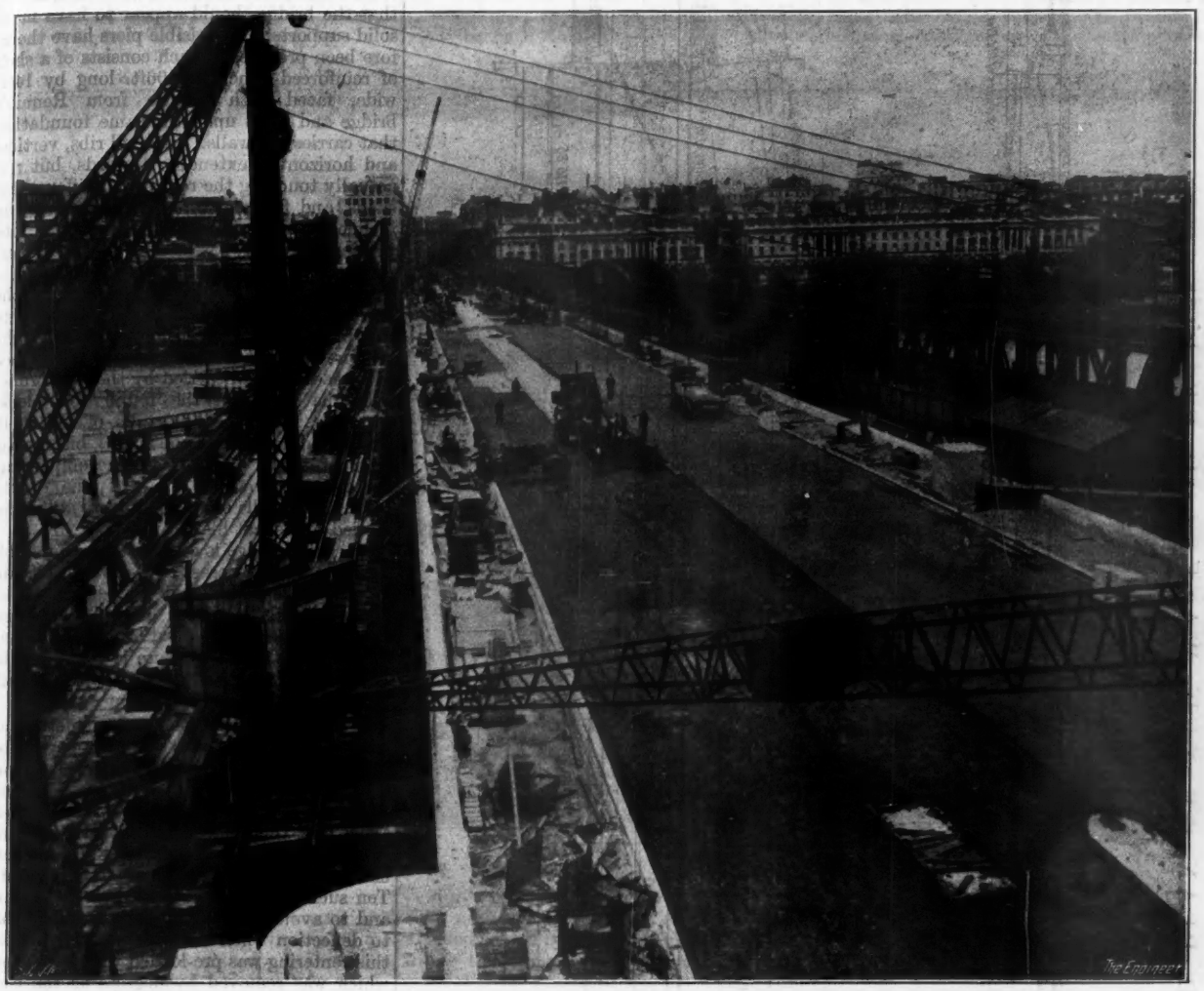
Sixty Years Ago

THE BRENNAN TORPEDO

IN our issue of July 14th, 1882, we find an account of the late Mr. Louis Brennan's torpedo, one of the earliest products of that ingenious inventor's brain. The device was developed in his native country, Australia, with the assistance of the Victorian Government, and had been very favourably reported upon by a committee of naval officers appointed by the Commodore in Australian Waters. Unlike the Whitehead and other "fish" torpedoes, the Brennan did not rely upon compressed air for its propulsion. It was fitted with two contra-turning co-axial propellers which were coupled to two small reels inside the body of the torpedo. From these reels fine-gauge steel wires were unwound on to two 3ft. diameter drums driven

WATERLOO BRIDGE OVER RIVER THAMES, LONDON

MESSRS. RENDEL, PALMER AND TRITTON, WESTMINSTER, CONSULTING ENGINEERS



by an engine at a peripheral speed of 100ft. per second, the drums and engine being carried on the torpedo-launching vessel. Thus the torpedo was driven forward at a speed of 15 to 20 knots by exerting a backward pull on the wires. The torpedo could be steered at will from the launching craft. To that end a device was provided whereby the relative speeds of the two driving drums could be altered. The reaction of the propellers rotating at different speeds was transmitted to a very sensitive rudder, with the result that the torpedo could be made "to follow as tortuous a path as a figure skater." The course and position of the torpedo were indicated to the operator by means of a pennon on a small telescopic mast carried on the hull. Many experiments with the torpedo had, it was stated, been made recently at Woolwich and Chatham, and there seemed to be little doubt that it would prove most valuable for the defence of harbours and creeks. . . . Brennan subsequently settled permanently in this country, and devoted his inventive genius to many subjects, notably a gyroscopically controlled mono-rail car and a helicopter. His ingenuity never earned for him the reward which was its due.

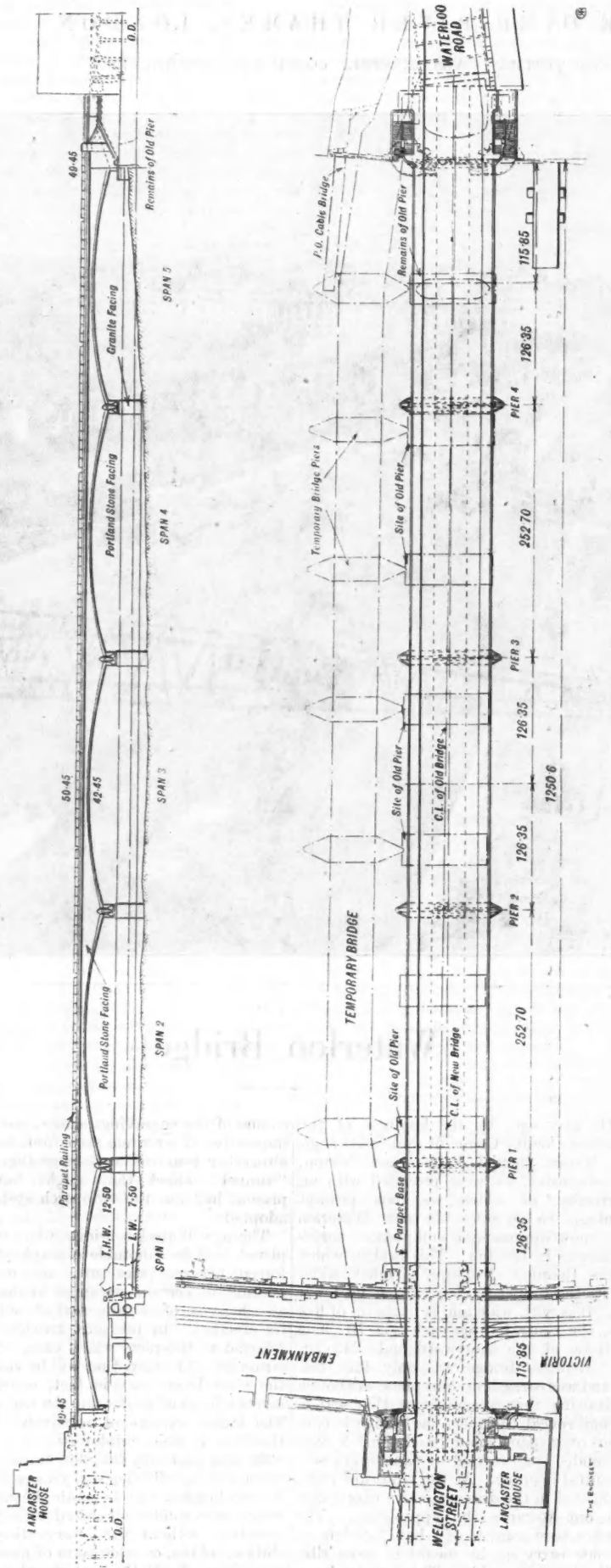
ENGINEERING SCHOOL AS A MEMORIAL.—The King has approved a plan to erect, after the war, an engineering and electrical school, which will form a new wing at the Royal Albert School, Camberley, as a memorial to the late Duke of Connaught.

Waterloo Bridge

SOME days ago, by the kindness of the London County Council's appointed engineers, Messrs. Rendel, Palmer and Tritton, of Westminster, we were provided with an opportunity, of which we took prompt advantage, to go over the new Waterloo bridge, now approaching completion, across the Thames in London. This bridge, which replaces Rennie's structure, is much wider than its forerunner, and is carried by fewer piers. It is 80ft. wide and is made up of five spans, the central three each 252·7ft. long and those at the shoreward ends 242·7ft. long. Rennie's bridge was only 42ft. 6in. wide and was carried on eight piers. Although the drawing that accompanies this article does not reveal the fact, the bridge is continuous over spans 1 and 2 and 4 and 5, with a suspended span carried by cantilevers over the central opening. At the landward ends, as indicated in the drawing, short cantilevers reach out towards the approaches. The superstructure consists of "box" girders on each side carrying, by means of cross ribs, a deck slab 33ft. wide. This construction, as one of the engravings shows, produces an impressive effect when seen from below and altogether removes any suggestion of that "tunnel" effect that might have been present had not the twin arch system been adopted.

The new Waterloo bridge, when it is completed, will be a notable example of a reinforced concrete structure, not merely on account of certain advances in design, but also because of certain methods adopted in its erection. In previous articles we have referred to the piers which carry the superstructure. The piers that will be visible from the river banks are, in fact, merely boxes surrounding and protecting the real supports. The latter consists of relatively thin, and therefore flexible, reinforced concrete walls, 83ft. long and only 2ft. 3in. thick. Each is carried by a solid block of concrete founded on the London clay beneath the bed of the river and is solidly connected with the superstructure without the intervention of any sliding, rolling, or other form of joint. There is sufficient flexibility in these thin walls to

ELEVATION AND PLAN OF NEW WATERLOO BRIDGE



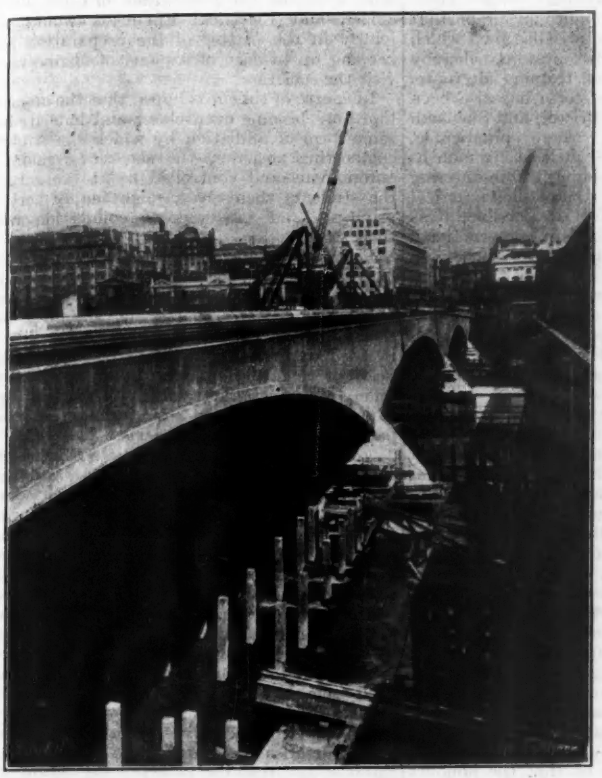
take care of movements of the structure due to temperature changes, &c. Whilst, however, they are amply strong enough to carry the weight of the bridge, such walls might suffer serious damage were a ship or barge to come into collision with them, and, moreover, it is desirable for æsthetic reasons that the bridge should appear to have more solid supports. The visible piers have therefore been provided. Each consists of a shell of reinforced concrete, 106ft. long by 14ft. wide, faced with granite from Rennie's bridge and built upon the same foundation that carries the walls. Internal ribs, vertical and horizontal, extending towards, but not actually touching the real piers, stiffen these shells, and further stiffening is provided by inclined transverse reinforced concrete ribs passing through passages in the real piers to connect the sides of the shell on opposite sides of the pier. Near the bottom the lowermost ribs of the shell are bonded into the pier proper and below that level the reinforcement of the vertical ribs is designed to spread the load carried by the pier proper over the whole of the foundation block. At their tops the side walls of the shells are carried up beneath the arches, but remain clear of them. One of the accompanying engravings shows a view of one of the piers. The walls of the shell have still to be carried somewhat higher.

Since the bridge is carried by such flexible supports, it was necessary to provide means of restraint. This job is performed by "inertia walls" at each end of the bridge, carried by separate piled foundations and to which the superstructure is connected by some form of tenon joint. More precise details of the design are not at present available.

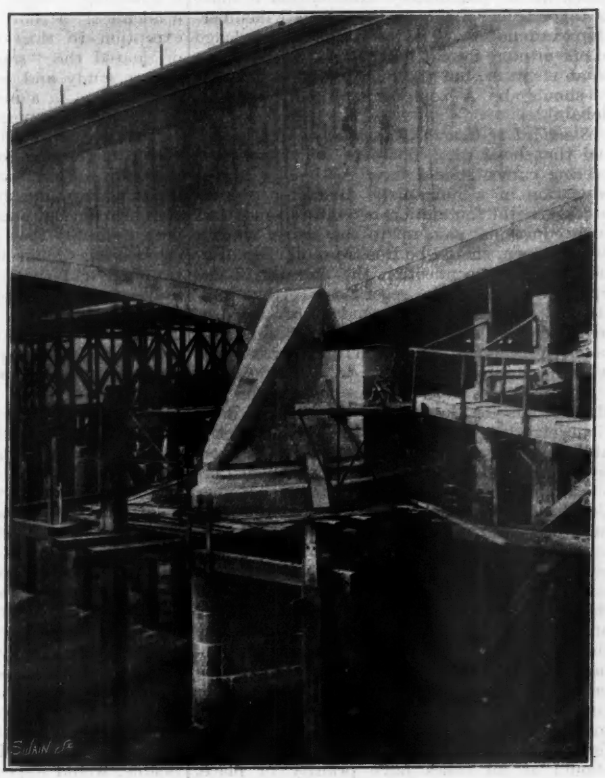
In the erection of the superstructure all but three of the spans were supported on timber centering carried on timber piles from the river bottom. Under two of the spans, where the requirements of navigation necessitated that there should be as little obstruction as possible, steel centering girders were used, supported by piles only at their ends. Ten such girders were needed at each span, and to avoid any possibility of troubles due to deflection when the concrete was placed, this centering was pre-loaded with kentledge, which was removed by degrees as the concrete was placed. At the northern end, where the bridge passes over the Embankment roadway, timber centering was carried by steel I beams. Each arch, after it was formed, was thus at first carried by the centering alone. The loads of the arches were transferred to the piers gradually by the use of jacks. This system, certainly novel to this country, possibly altogether new, was adopted to provide for any possibility of initial settlement by a pier when the load was first applied, and we learn that it proved very successful. When the loads had been transferred—there was incidentally very little settlement—the jacks were used to bring the bridge exactly to level, and concrete was then placed to connect the superstructure solidly with the piers.

Several other matters in relation to the bridge deserve notice. All concrete used in its construction was handled by plant specially erected on the southern bank and carried to the bridge by conveyors and in skips hanging from the cranes running on the construction gantry erected by the contractors upstream of the structure. Once placed in position, all concrete was vibrated. Reinforcement for the concrete was invariably connected together by welding. Under the southernmost arch, up against the abutment, there is a memorial panel to Rennie's bridge, which includes two of the columns that surmounted piers in his structure. From this point, owing to the

twin-arch arrangement of the bridge, one can look across under the bridge into the Aldwych tramway tunnel on the opposite side of the river. Each of the twin girders, apparently solid, is in fact hollow. Water and hydraulic power mains and telephone cables are carried within. Drainage from these spaces is effected by pipes that emerge above the piers, but are concealed by the shell piers and discharge into the river. The railings being installed along the bridge are temporary and will eventually be replaced by others of more suitable design.



VIEW OF BRIDGE FROM SOUTH



PIER OF NEW BRIDGE

VIEW BENEATH BRIDGE

The appointed engineers for the bridge are Messrs. Rendel, Palmer and Tritton, in association with the London County Council's Chief Engineer, Sir Peirson Frank, M. Inst. C.E., F.S.I., and in collaboration with the appointed architect, Sir Giles Gilbert Scott, R.A. The contractors are Peter Lind and Co., Ltd. Admiration may already be expressed for the engineering and structural side of the design of the bridge. Judgment on its æsthetic merits, however, must be at present reserved. Except for the impressive view beneath the bridge, which indicates that any sense of tunnel effect has been avoided, it is at present impossible adequately to see the bridge, the elevation of which is concealed on one side by the contractors' gantry and on the other side by the temporary bridge. As the bridge is now substantially complete it may be presumed that the contractors' gantry will soon be removed.

Engineering Education

THE Institution of Civil Engineers recently circulated a "Memorandum on Engineering Education." This Memorandum is far too long for us to publish in full, despite the interest and importance of its subject. It reviews the historical development of technical education and the part the Institution has played in that matter, describes the present position and discusses various suggestions that have been put forward. It deals with education and training from elementary schooling, through university and college, to practical experience and the standards required for associate membership. In what follows we take some extracts from this Memorandum.

STANDARDS OF GENERAL EDUCATION

Opinions have varied considerably as to the requirements in respect of the general education of a young man intending to become an engineer. On the one hand, it was considered that such a person, by the time he left school, should have reached matriculation standard and should have shown an aptitude for mathematics and for science, to ensure that he would be in a position to profit by the instruction he would subsequently receive in the more advanced stages of these subjects and in their application to engineering problems. On the other hand, it was asserted that, having regard to the fact that professional engineers were recruited from all classes of the community, entry into the profession should be open to all, irrespective of the degree of their secondary education.

The Institution has consistently supported the former view on the grounds that for young men to commence their engineering studies with imperfect preliminary education tended to lower the status of the profession and, as the standard of general education improved, this view has gradually gained ground.

Common Preliminary Examination.—Immediately before the outbreak of the present war, eight engineering institutions had co-operated in the setting up of a Joint Examina-

tion Board for the purpose of establishing a "Common Preliminary Examination" and it appeared that this problem, which had for so long proved one of controversy, was nearing a solution. Unfortunately, the war intervened and the time was not found opportune by some of the said institutions to conform fully with the scheme.

It may be noted that, rightly or wrongly, the Institution insists on a foreign language as one of its examination requirements. If this is not taken in the preliminary examination it must be taken before sitting for the associate membership examination. The possession of knowledge of one or more foreign languages is a great asset to an engineer, but the question as to whether it should be a compulsory qualification is debatable.

Standard of General Education.—It is essential that boys who choose to follow an engineering career should have received a liberal education of a humanistic character providing a general foundation of culture, and that such education, say, up to the age of sixteen or seventeen, should be free from all specialisation. In this connection the findings of the Spens Committee in regard to certain substantial changes recommended of English, mathematics, and general science* for boys between the ages of eleven and sixteen are wholeheartedly endorsed.

School-leaving Age.—The school-leaving age should not be less than sixteen or more than eighteen, the upper limit being desirable in the case of those entering a university. After a boy has taken his School Certificate, he may wish to study for the Higher Certificate, in which case mathematics and natural science may well form a basis for further studies. The introduction into the school curriculum of such subjects as surveying or engineering drawing is to be deprecated and should be deferred until the boy has left school and better facilities for obtaining satisfactory tuition are available. On the other hand, free-hand drawing, map reading, and practice in ordinary handicraft work, such as carpentry or turning, may usefully be included as supplementary subjects, provided they do not interfere with the normal school instruction, which should at all times have priority of place. Whilst it is not the intention that boys should decide at an early age the career they are to follow, there is reason to believe that the schools could do much to help the boy to make up his mind some little time before leaving school.

University Education

Functions.—The function of a university in so far as this concerns the education of engineers is to provide the highest form of academic instruction in the general principles of engineering science, supplemented by appropriate demonstration in the laboratory and in the drawing-office.

The close and intimate association during three or more years of undergraduateship with teachers of experience and repute; the freedom to develop powers of application and individuality on the basis of independent study and to share the corporate life of the university in common with other undergraduates pursuing studies of considerable variety and with differing outlooks and objectives; the association in greater or less degree with original research which is being carried out within the university, must tend to stimulate a broad outlook and a sense of initiative which will prove invaluable to the individual who is to follow a professional career which calls for knowledge over a wide field of human endeavour and for association with men of affairs and business.

Since it is the primary duty of universities to provide to a large extent the future leaders in engineering, it is essential not only that the students should be prepared by a liberal engineering education to follow the most diverse post-graduate activities, but that this form of education should be made even more accessible on merit to all classes of the community.

It may be observed that no attempt has ever been made to estimate the number of graduates who can be absorbed annually into the constructional engineering profession and there is reason to believe that at times the supply is greater than the demand, with the result that engineering graduates drift into other walks of life. This must have a detrimental reaction on the profession as a whole and may account for the oft-repeated assertion that the engineering profession is overcrowded.

Order of Practical and Academic Training.—Generally speaking, the course for an ordinary engineering degree extends over three academical sessions, though an important exception to this occurs at Glasgow, which originated the "sandwich" system, whereby college study and practical training alternate. This system in a modified form has also been adopted at Birmingham, Bristol, and Sheffield.

Engineering students, where practicable, should have undergone for at least six months some form of practical training before entering the university and should resume such practical training during vacations. If possible, it is very desirable that students in constructional engineering should have done some mechanical training, and the period between school and university is an opportune time for a short training of the kind. By this means the undergraduate establishes and preserves contact with practical engineering work which assists him to preserve a proper balance when pursuing his academic studies.

Curriculum.—The first year at a university is devoted to the study of general scientific principles, namely, mathematics, mechanics, physics, and chemistry. The second year is given up to acquiring the fundamentals of general engineering science—strength of materials, theory of structures, theory of machines, heat engines, electricity, and engineering drawing, &c.—and up to this stage the curriculum is usually common to all students whatever their ultimate objective. In the third or final year the prescribed courses of studies are usually grouped into the branches of engineering in which degrees are conferred.

Honours degrees are conferred after courses on parallel but more advanced lines involving in some cases a fourth year at the university. The ideal, although it may not always be practicable, would appear to be that the honours course should be a separate course throughout. Diplomas are also awarded at some of the universities, but these are becoming fewer in number.

It will thus be seen that the courses leading to degrees are fundamental in character, with a thorough grounding in the general principles which form the basis of engineering science, and it is to be hoped that they will remain so. There is an inevitable demand for specialisation, but the universities have so far been successful in resisting over-specialisation.

Instruction in Engineering Economics, &c.—There would appear, however, to be a certain deficiency in the treatment of the application of engineering science to engineering practice, and it is with the object of correcting this and at the same time of advancing the fundamental character of university instruction, particularly in connection with the closer study of the economics of engineering projects, the organisation and management of engineering works, human psychology, and the relations of æsthetic considerations to engineering design and construction, that the Council of the Institution have recently approached the universities, urging the eventual inclusion of these subjects within the curricula of the schools of engineering. The present difficulties in introducing this range of subjects into an already crowded curriculum were appreciated, and the Council have been all the more gratified at the sympathetic replies received to their representations, and it is hoped that eventually these subjects may find a permanent place in the academic education of engineers. The establishment of a lectureship at Cambridge University in "Engineering Economics, Management and Aesthetics" has a similar result in view.

Although an introduction to some of these subjects is desirable during the undergraduate stage, intensive study of the subjects must be regarded as a matter for post-graduate work.

University Engineering Societies.—A number of universities have engineering societies, and it is suggested that a closer association between these societies and the professional institutions would be of advantage to both. The Institution of Civil Engineers has recently been in communication with these societies, and as a result a list of members of the Institution prepared to give lectures or talks has been compiled, and the engineering societies have taken advantage of the offer. More recently it has been agreed to extend the scheme so that the Institutions of Civil, Mechanical, and Electrical Engineers would act jointly in the matter of the preparation and keeping up to date of a panel of engineers to visit the societies.

In course of time it is hoped that the association may become even closer and indeed that some form of affiliation by which the student engineering societies, the societies remaining autonomous and controlled as at present by the students themselves, might enjoy certain privileges and assistance in connection with their work.

Post-graduate Training.—In view of the high degree of specialisation in engineering, it becomes ever more important to stimulate post-graduate courses of training, but the multiplicity of such courses should be avoided, and training and research in particular fields of engineering should be apportioned to different universities, suitably situated and endowed to give the best teaching in that particular branch of the science.

Technical Schools and Universities.—An avenue should be provided whereby students at technical schools who show ability and aptitude should have an opportunity of proceeding to a university, and it is suggested that a course at a technical school to cover the first year at the university should be organised, so that specially selected students might proceed to the university for the second and third years of degree courses. Except for this, the activities of the university and of the normal technical school should not coincide or attempt to replace each other.

State Bursaries in Science.—Finally, it is hoped that the recently established scheme of State bursaries in science will be extended after the war, and that the Board of Education, the universities, and the engineering institutions will co-operate in preparing a plan in so far as engineering students are concerned to secure the best selection from those leaving the secondary schools.

Technical Education

Definition.—Technical education has been defined as "instruction in the principles of science and art applicable to industries and in the application of special branches of science and art to specific industries or employments."†

The function of technical colleges or institutes is to provide the more advanced forms of "further" education specially adapted to local needs, *e.g.*, engineering courses in relation to the design, manufacture, and use of machinery in industrial districts; technological courses in specific industries, such as textile manufacture, printing trades, &c.; and courses in commerce, domestic science, &c.

In so far as the engineering profession is concerned, technical colleges afford opportunities in all parts of the country for study with a view to obtaining a certificate, diploma, associateship, or an external degree which will exempt in part or in whole, or on a subject-for-subject basis, from the examinations required of those becoming members of the professional engineering institutions, or in some cases with a view to sitting for the examinations themselves.

The facilities afforded for technical education in this country have lagged behind those existing in many other countries, where their industrial activities are comparatively new-born.

Practical Training

Pupilage System.—A sound practical training is an essential part of the education of every engineer, and the pre-eminence of British engineering during the Victorian era was in no

* Report of the Consultative Committee set up by the Board of Education on Secondary Education, H.M. Stationery Office, 1939.

† Education Act of 1889.

small measure due to the system of individual premium pupilage, which was then the principal means of preparation for the professional practice of engineering, by which a young man learned at first hand, under the personal supervision of an engineer of repute, the fundamentals of the design and execution of engineering works of construction.

It must not, however, be inferred that the system was free from defects. An engineer may have been tempted to take more pupils than he could properly train, or, due to other preoccupations, to hand them over to subordinates who might not be competent or willing to give them adequate instruction. Difficulties might arise when work was slack and the pupil left too much to his own devices. On the other hand, the pupil of an engineer who conscientiously fulfilled his obligations had unrivalled opportunities of obtaining advice and instruction in connection with design and construction, as well as an insight into the problems of procedure and administration which form such an important part of the responsibilities of every practising engineer. Furthermore, his chief was often able at a later stage to influence his advancement in the profession.

As, however, the science of engineering progressed and displaced the intuitive methods of the early engineers, it became ever more important that the engineering student should also receive adequate instruction in the theory of engineering science, and the establishment of "schools of engineering," to which reference has already been made in the introduction to this memorandum, attracted an ever-increasing number of persons on leaving school to the universities and to engineering colleges, there to undergo a three or four-year (or a two-year) course of study leading to a degree (or diploma).

Thus, by the time the average young man, whose means were usually strictly limited, had completed his theoretical studies and was seeking the practical training and experience which would enable him to complete his qualifications as a professional engineer, he was seldom in a position to find the premium, the payment of which was one of the usual conditions of articled pupilage. A practice has consequently arisen by which many engineers, recognising the potential market value of these men, are prepared to employ them on their staffs at a small salary, on the understanding that they will be afforded opportunity to acquire knowledge in the practice of engineering.

Need for Training to be Systematised.—It is desired to emphasise that practical training for engineers in constructional work has not been sufficiently systematised, and it would appear desirable for the Institution to take steps to effect a more clear-cut policy in relation to such training. Thus, a number of important corporations having large engineering departments do not take any part in the training of engineers, but recruit their staffs entirely from fully qualified engineers, *e.g.*, the Port of London Authority, the London County Council, and the London Passenger Transport Board, whereas in other cases engineers who have not sufficient opportunities for instructing young men can and do accept pupils.

The desired result might, for example, be achieved by the setting-up of a panel of engineers, engineering firms, and departments willing to accept young men for practical training under one or more of the classes set out above. The engineers in question should be prepared to accept some obligation in this connection, and to adhere to certain simple rules of guidance which might be laid down by the Institution.

Technical Assistants

From time to time there has been apparent the need for some means of associating with the work of the Institution persons whose attainments and experience enable them to collaborate with civil engineers in the furtherance of the objects of the Charter, although they are not civil engineers by profession.

Consideration has recently been given to the desirability of devising some means by which the Institution might recognise the important part which such persons play in the design or construction of engineering works. They possess experience and knowledge of a kind indispensable to engineers in carrying on their work, but are not by their qualifications eligible to become corporate members.

It seems desirable that men of this type should be assisted in maintaining and improving their technical knowledge by intercourse amongst themselves and with corporate members; that the Institution should be in a position to encourage and further amongst them means of improving their technical knowledge; and that the Institution should use its influence to ensure that sound technical education and technical training of steadily improving standards is made available in order to provide for future recruitment.

The recognition of such men by the Institution should receive serious consideration and might take one of two forms—first, by attaching them to the Institution as non-corporate members, with privileges in regard to attendance at meetings and the receipt of the Institution *Journal*; or, secondly, by giving them a certificate of competency for which they could qualify without direct affiliation with the Institution. In either case, definite qualifications would be required of those awarded the certificate or diploma, and such qualifications would no doubt have to include not only an adequate period of training and experience in an office or in or upon works, but also a test by means of an examination of a technological character, say, of a standard equivalent to that of an Ordinary National Certificate.

It seems probable that the establishment of a recognised standard of attainment for the class of person envisaged would raise the question of the introduction of a National Certificate in Constructional and Building Engineering as a counterpart to the existing National Certificates in Mechanical Engineering and in Electrical Engineering. There is reason to believe that such a development would fill a long-felt need and would be of great benefit to that section of the industry which will play an active part in the work of reconstruction.

Post-Training and Refresher Courses

This memorandum has, up to this point, dealt with the education and training of the engineer to the time he is admitted to corporate membership of the Institution, and is consequently regarded as being qualified for entry into the ranks of the profession.

There would, however, appear to be a need for the establishment of further educational facilities of a post-training character for practising engineers, so that they may keep themselves abreast of developments within the particular branch of engineering to which they are attached.

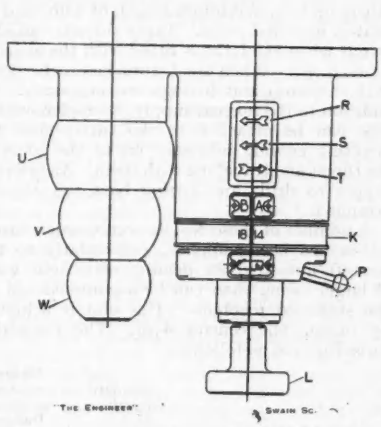
At present, the only means a man has of doing this is by attending the meetings of various engineering institutions, or reading the publications issued by those societies, of perusing articles in the engineering Press, or by making use of the various technical libraries at his disposal.

The establishment of post-training courses for young engineers, and of refresher courses for those of more mature years, could be undertaken by the Institution, and might consist of a series of, say, four or six lectures, periodical courses, or conferences extending over one or more days. These would deal with, in the case of post-training courses, matters which do not usually form the basis of study at a university (which, as has already been seen, is largely fundamental in character), such as engineering economics, management and administration, æsthetics, and psychology, or, in the case of refresher courses, matters which have been the subject of recent development, *e.g.*, soil mechanics, and the like.

A staff college might also be set up and endowed, to which young men specially earmarked by their firms for responsible positions in managerial or production activity, should be seconded for, say, a period of six months.

Heavy-Duty Combination Turret Lathe

THE capstan and turret lathes produced by Alfred Herbert, Ltd., of Coventry, have undergone many changes in design to meet the requirements of "Ardoloy" and other high-speed cutting alloys. The ability of these tools to remove metal rapidly at high speeds has necessitated considerable increases in power, stability, rigidity and durability in the machines on which they are used. These conditions, it is claimed, are fully provided for in the Herbert No. 9B combination turret lathe, illustrated herewith, a medium-sized, heavy-duty machine, having a swing of 22½in. over the bed covers.



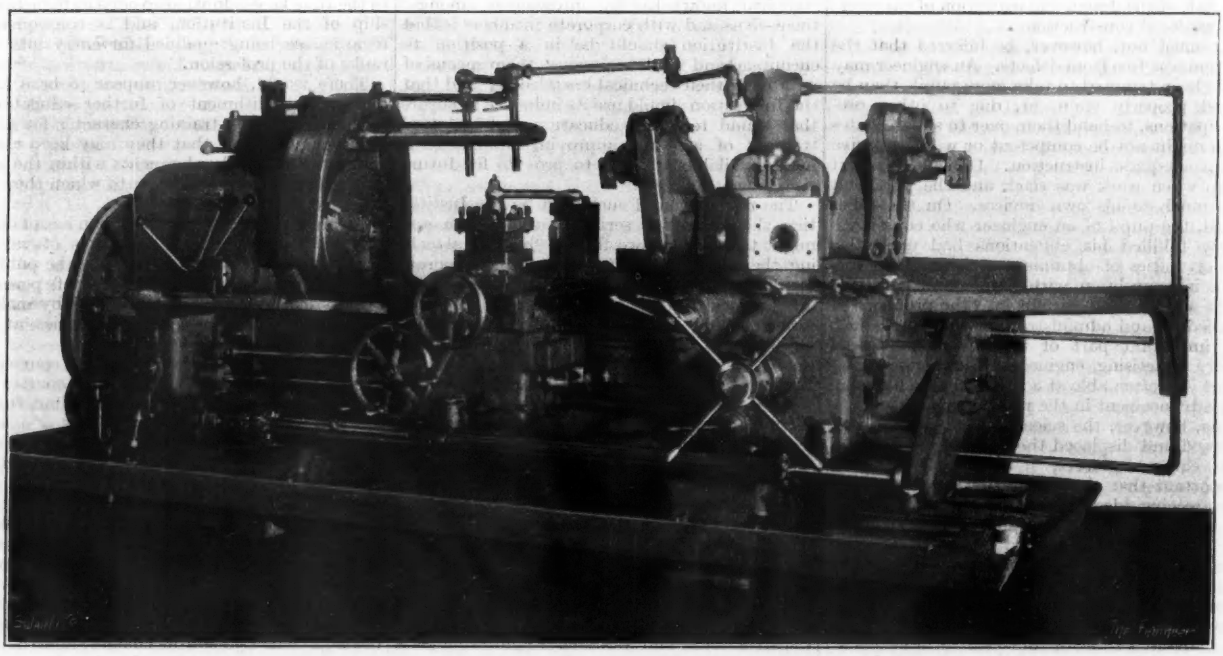
SPEED INDICATOR

The foundation on which the machine is built is the heavily ribbed Flamard hardened bed, with prismatic guides having a hardness of 478/555 Brinell. The bed is designed to resist the forces set up by the heaviest cuts of which the tools are capable. The prismatic guides ensure full support to the saddle and turret slide under the heaviest cut. Additional rigidity is provided to the turret tools by the overhead support. The chip clearance is ample to enable the chips to fall clear through the bed, an important feature in view of the rate at which modern cutting tools remove metal. The wear-resisting qualities of the hardened guides ensure the maintenance of the original accuracy for a long period. As a further safeguard, cast iron covers are fitted to the front of the saddle to protect the bed from damage which might be caused by dropping tools or work on the guides or by the continual abrasion of the chips and turnings. The covers are in contact with the prismatic guides, thus excluding dirt and chips, and the ways of the bed are continually lubricated and are kept clean by felt pads on the saddle and turret slide.

The headstock is driven by a single pulley from a line shaft or by a self-contained motor and guarded vee ropes. A 10 H.P. or 15 H.P. motor for 200/550 volts, two or three-phase, 50 cycles A.C., or 200/500 volts D.C. is supplied. All the electrical equipment is included, as it has been specially developed for the machine. The motors fitted have been specially selected for overload capacity and protection against moisture and swarf. Start-and-stop push-buttons are mounted on the top of the feed-box. The headstock provides sixteen spindle speeds from 14 to 403 r.p.m. forward and four reverse speeds from 14 to 54 r.p.m. Changes are made through sliding gears of heat-treated chrome steel, mounted on multi-splined shafts of similar material. An interlock prevents changing from a high forward speed to a high reverse speed. The selection of speeds is made easy by the patented speed indicator shown in the line engraving. The fluted knob L is rotated

HEAVY-DUTY COMBINATION TURRET LATHE

ALFRED HERBERT, LTD., COVENTRY, ENGINEERS



to bring the speed required on the dial K to the top. Three arrows—R, S, T—then appear in the aperture on the top of the barrel and indicate the positions in which the levers U, V, and W must be placed. The letters B and A on top of the barrel show which of the two speeds is in use, according to the position left or right respectively of the starting lever on top of the headstock. Eight forward speeds are available in either position of the starting lever when a small lever on the left front of the headstock is moved to the right. When this small lever is moved to the left, four forward speeds and four reverse speeds are provided with the starting lever in the left-hand and right-hand positions respectively. The lever P, when placed in the same direction as the small lever on the left of the headstock, indicates on the barrel the direction of the spindle rotation. A brake is provided to bring the spindle quickly to rest from any speed when the starting lever is placed in the neutral position. The spindle is bored 4¼in. diameter, and is flanged so that chucks may be bolted directly to it. The bearings are bronze lined with white metal.

The feed-box provides eight automatic feeds, from 40 to 480 cuts per inch in both directions to the saddle and turret slide, changes being made by a finger-controlled pilot wheel and levers. A slipping clutch is incorporated in the mechanism to protect the feed gears. The saddle sliding and surfacing feeds are controlled by levers on the apron. Quick power traverse to the turret slide relieves the operator of fatigue and enables the slide to be moved quickly along the bed in either direction. The pilot wheel is automatically disconnected and remains stationary when either quick-power traverse or automatic feed is in use. The turret is carried on a frictionless mounting, so that it can be easily and safely rotated by hand, irrespective of the weight or uneven mounting of the tools. To enable length dimensions and diameters of repetition work to be accurately duplicated, hexagon stop bars are provided for the saddle and turret slide, the saddle bar being operated by hand and the turret bar being automatically indexed as the turret rotates. A patented unison stop adjustment enables both stop bars to be adjusted together to accommodate variations in the length of castings or forgings. The transverse motion of the cross slide is controlled by stops on a square stop bar operated by hand. Chips are excluded by a hinged cover. To duplicate length dimensions to a fine degree of accuracy, the saddle and turret slide are fitted with indicators which enable the same amount of pressure to be put on the stops for length dimensions on each work piece.

The machine is fitted with chasing mechanism, which will cut four different pitches, right or left hand, for each leader. The four pitches are multiples of the pitch of the leader. Thus a four-per-inch leader will cut threads of 4, 8, 12, or 16 threads per inch. A quick-withdraw mechanism ensures that the chaser is withdrawn from the work at the same time as the nut is withdrawn from the leader. A set of seven leaders will cut 28 threads from 4 to 28 threads per inch. A set of seven metric leaders will cut 28 threads from 7 to 1 mm. pitch.

Additional equipment includes a taper attachment which will deal with internal or external tapers up to a maximum length of 13in. and of 30 deg. included angle. Taper threads can also be cut when the lathe is fitted with the chasing attachment. When steel work has to be dealt with, a pump and fittings are necessary. In addition to the normal supply, a supplementary pipe can be attached to the turret slide for directing cutting lubricant on to the tools in the turret and travelling with them. An internal supply to drills and boring bars can also be arranged.

A number of these No. 9B combination turret lathes has been supplied, particularly to the aircraft industry, for dealing with light work of larger swing than can be accommodated on the standard machine. This end is achieved by raising the centres 4½in. The respective capacities are as follows :—

	Standard machine. Inches.	Raised centre machine. Inches.
Swing over bed covers ...	22½	30
Swing close to cross slide ...	21½	29
Swing over cross slide ...	12½	21
End of spindle to face of turret, maximum	60	60

MORE METAL IN SIX MONTHS.—A Montreal engineering concern has started work on a 3 million dollar plant for the Aluminium Company of Canada, at Latuque, Quebec. This plant will take about six months to construct.

Institution of Mechanical Engineers

APPLIED MECHANICS GROUP

As a result of a suggestion made recently to the Institution of Mechanical Engineers, a Specialised Group on Applied Mechanics is being formed. Its first meeting will take place this evening at the Institution, when a paper on "The Measurement of Torsional Vibrations" will be presented by Mr. R. Stansfield. Dr. H. J. Gough has consented to serve as the first Chairman of the Group, and Professor F. C. Lea and Dr. S. F. Dorey will represent the Council on the Group Committee, to which eight corporate members of the Institution will be elected. The purpose of the specialised groups is to afford a more rapid platform for papers on specialist subjects, and it is recognised that the Applied Mechanics Group will meet a long-felt need within the Institution. Subjects coming within its general title are dynamics of machinery, including balancing; vibration problems and the measurement of vibration; stresses in machine parts and structures; gearing; properties and strength of materials, including elasticity and plasticity; mechanics of fluids and lubrication.

"SLIPCLEAN."—We have received from Slip Products Company, Ltd., Ling House, Dominion Street, London, E.C.2, a sample tin of "Slipclean," a new antiseptic liquid cleanser for removing oil, grease, tar, paint and other dirt from the hands. The liquid consists of a blend of solvents and emulsifying agents, to which lanoline and petroleum jelly are added to counteract the tendency of the solvents to harden or dry the skin. The antiseptics embodied in it are claimed to prevent dermatitis and skin troubles of all descriptions. We have tested the sample and have found it highly efficient as a dirt remover and pleasant and easy to use. A few drops rubbed well into the skin, followed by a brief rinsing with soap and water, seem to be sufficient to remove the most stubborn dirt, even when highly engrained. The treatment leaves the hands not only clean, but pleasantly soft and comfortable. In these days of soap shortage access to a supply of "Slipclean" would be an undoubted boon to many war workers, particularly to women, who frequently find the soiling of their hands a highly objectionable concomitant of their work.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The United States Texas Tin Smelter

Early in June tin-smelting operation on a large scale commenced at the United States Government tin smelter in Texas city. According to *Tin*, the official monthly bulletin of the Tin Producers' Association, the production of this important plant should help to solve one of the major problems of tin supply, resulting from the Japanese occupation of Malaya and the Dutch East Indies. Singapore, Penang and Banka had a smelting capacity sufficient to enable them to treat two-thirds of the world's tin ore output. Now that these smelters are in enemy hands, only the smelting facilities of Great Britain, the United States, and the Belgian Congo remain available to the United Nations. Approximately 50,000 tons of tin per annum is the practical limit of British smelters, whilst the Belgian Congo can smelt about 10,000 tons, although its capacity has been increased. The new Texas smelter, however, should more than fill the gap between smelting facilities and current ore supplies. The Texas City smelting project, which is operated by the Tin Processing Corporation on behalf of the United States Government, was first mentioned at the Pan-American Conference of Havana in July, 1940. It was planned to treat 50,000 tons of ore, equivalent to 18,000 tons of metal per annum, and the contract for its construction was signed in February, 1941. The first of the smelter's seven furnaces was put into operation on April 9th, 1942, and the plant has been extended even while under construction. It is estimated that the official capacity of the plant will be 25,000 tons per annum of refined tin and that before the end of 1942 the capacity will be increased to about 50,000 tons per annum. This is not the first attempt to establish a tin smelter and refining industry in the United States. In 1916 efforts were made to found a tin-smelting industry, but were relinquished in 1924. The American Smelting and Refining Company produced 45,000 tons of tin, of which 7452 were smelter production and 37,738 were smelted and then electrolytically refined. Up to 1917 the initial operations were profitable, but during the seven years previous to 1924 the position altered and the smelting operations resulted over the whole period in a loss to the operating company of 2,160,085 dollars and the electrolytic tin-refining operations in a loss of 292,705 dollars. In 1924 the output amounted to 434 tons and in that year the last of the smelting plants was dismantled. Other attempts to establish a smelting industry in the United States have been largely of an experimental nature.

The Pig Iron Market

Pig iron producers are facing the third quarter of the year with the prospect of having to meet an even heavier demand than in the period just over. The Control arrangements have, in the past, prevented any congestion of orders at the blast-furnace plants, and there is no reason to expect such a development in the future. The demand for foundry pig iron is sufficient to absorb production, excepting in the high-phosphoric grades, of which stocks are said to be accumulating. A wider use, however, is being found for these descriptions, and under the encouragement of the Iron and Steel Control they are used to some extent as substitutes for grades of pig iron, which are in less liberal supply. The Midland foundry pig iron producers are supplying consumers in a number of districts which before the war took their supplies from other quarters, and this leaves free the capacity which can be used for the production of other more urgently required qualities. The hematite position is tight, and this iron is only released for purposes of an essential character for which no other description will serve. The demand for hematite, however, has been reduced by the use of substitutes, but it is in excess of available supplies. The use of refined and low-phosphoric pig irons instead of hematite has brought about a certain amount of stringency in the position of these pig irons, and wherever possible consumers are being urged to avoid using irons with a phosphorus content of less than 0·7 per cent. By careful distribution, however, the Control has been able to keep the firms engaged on work of national importance fully supplied. Consumers who do not come within the priority classes may find some difficulty in obtaining their requirements of this class of pig iron. There is an insistent demand for basic iron, but the wants of the steel works are fully met, and care has been taken by the Iron and Steel Control to safeguard the future needs of consumers, so that the position may be considered satisfactory, although probably there is not much margin of production over consumption. The shipping position makes it advisable to restrict the amount of foreign ore imported, and successful efforts have been made to increase the output of the home mines.

The Midlands and South Wales

It is evident that a small amount of iron and steel will be available for the ordinary commercial work during the present quarter. Export business also will be of an insignificant character, and practically the whole of the British steel production will be devoted to war requirements. Production has not only been maintained, but in various directions has been stepped up, and there is no likelihood of any relaxation in the efforts to achieve large outputs during the summer, when normally production declines somewhat. Arrangements have been made by which the workmen's holidays will be so arranged as not to interfere with production. On the other hand, the demand from the consuming industries shows a tendency to increase, and it is expected that during the third quarter of the year the works will experience an even greater pressure of demand than in the first six months. There has been little change in the incidence of demand for some time. Consumers' requirements are sufficient to absorb the whole of the British output of semis and most of the imports coming from the United States. Expansion has probably reached the limit in this department, but by careful distribution the Iron and Steel Control maintains adequate supplies of semis to all consumers engaged in the national effort. The re-rollers' position therefore is not unsatisfactory, and outputs are on a good scale. There are, however, exceptions to this rule, and in some cases the re-rolling works could undertake more business than they have on hand. The steel makers continue to report a weak demand for heavy structural steel. The majority of the constructional engineering firms are not well employed. The call for plates and alloy and special steels is insistent, and is taxing the resources of the producing works. Lately there has been an increase in the requirements of the railways and collieries, but the Control has managed to maintain full supplies to these important industries. In South Wales the steel works are employed to capacity, almost entirely upon war work. The production of steel has been kept at a high level, but the tinplate industry is only moderately employed. This is the result of Government restrictions upon the use and export of tinplate, although these are recognised as being necessary under the existing war conditions. Sheet makers are moderately busy.

The North-East Coast and Yorkshire

Although the advance of 3s. per ton in the pithead price of coal will result in an increase in costs to the iron and steel industry, the largest consumer of industrial fuel, it is believed that adjustments will be made by using funds in the industry, as well as with Treasury help, by which an increase in the official prices of iron and steel will be avoided. The market has developed a rather quieter appearance, owing to most of the allocations having been covered, but it is expected that an increase in industrial activity will occur during the coming quarter as a result of a speeding up in the armaments and munitions drive, but it is also suggested that the peak of production in these industries has been nearly reached. The demand for semi-finished steel seems to be growing, and although imports continue to arrive, consumers have to depend largely upon home production. As it is, the entire output of billets, blooms, and sheet bars passes into immediate consumption. The re-rolling industry, which after a somewhat quiet period is well employed, is using considerable supplies of defective billets and shell discard steel, which helps the billet position to some extent. The demand for heavy structural steel is quiet, and most of the producing works would be able to accept additional orders. The munitions and aircraft industries continue to take large quantities of special and alloy steels, and although the production has been largely increased during the past twelve months, consumers' requirements are so large that the position remains rather tight. Heavy tonnages of ship and tank plates are required, but the works are maintaining satisfactory supplies to the consuming industries. The general position of the Yorkshire iron and steel industries has not altered during the past few weeks. The demand for strip has sharply expanded lately, but consumers are obtaining their requirements. Business in acid carbon steel is active, and the consuming industries are rapidly taking up the production.

Scotland and the North

Now that practically all consumers have placed their allocations for the third quarter, the iron and steel market has not so busy an appearance as a week or two ago, but the industrial activity at the works has been maintained without a check. The spread-over system, which has been adopted for holidays, has enabled outputs to be kept at a good level, although there have been some stoppages, due to the necessity for overhauling and repairing plant. Normally the fair holidays would have started on July 17th and would have meant a complete cessation of operations at the steel works. The feature of the position is the abnormal demand for plates, which are required chiefly by the shipbuilding and boilermaking industries, although the tank makers are also providing an important outlet. There is a tendency for delivery dates to lengthen, but it is believed that this development can be avoided by a measure of standardisation. The demand for some time past has included a number of sizes and shapes, which have increased the difficulties of the manufacturers. Business in heavy joists and sections is somewhat slow and most of the works producing this class of material would be able to undertake additional orders. The re-rolling industry, also, is not so well employed as at the beginning of the year and the volume of new business coming forward shows a tendency to shrink. The sheet makers are moderately well employed, principally upon black sheets. An active business is passing in steel bars. The engineering industry is taking considerable supplies of the larger sizes, whilst the demand for small bars has also strengthened. Business in reinforced concrete bars has become rather quieter. In the Lancashire market the demand for plates is maintained, but it is reported that the boilermaking industry is experiencing a slackening in the volume of new business coming forward, and this may be reflected in an easing in the plate position. Lately there seems to have been an increase in the demand for colliery steel and works producing this class of material have good order books. The steel works on the North-West Coast have sufficient orders in hand to keep them busy for the third quarter.

Copper, Tin, Lead, and Spelter

The non-ferrous metal position is not unsatisfactory. Supplies of copper and lead are sufficient to meet the requirements of the war industries, but in the case of tin and spelter the Control has to exercise considerable care to spread the available supplies evenly over the consuming industries. Whilst there are no reports of firms engaged in the national effort having to go short of either of these two metals, the position is stringent, and there is no surplus available after the requirements of the war industries have been met. Supplies of copper continue to reach this country in adequate quantities, and the pooling arrangements which have been made to ensure supplies to the United Nations, while they have proved satisfactory, have necessitated great care on the part of the Control in the distribution of the metal. The consumption of copper, heavy as it is, appears to be increasing, and since it is so important a material in the production of armaments and munitions, there is little likelihood of the national requirements decreasing during the war. The United States Bureau of Mines gives the domestic smelter output of 1941 as 966,072 tons, compared with 909,084 tons in the previous year. The refinery output was 975,408 tons against 927,239 tons in 1940, and the refinery production, domestic and foreign metal, together totalled 1,395,308 tons, compared with 1,313,556 tons in 1940. On December 31st, 1941, the stocks of refined copper totalled 77,500 tons, compared with 91,500 tons at the end of the previous year. . . . The situation in the tin market has not altered, and vigorous efforts are being made to stimulate production in the producing countries controlled by the United Nations. Satisfactory reports have been received of increases in the outputs in Bolivia, Nigeria, and the Belgian Congo, although under wartime conditions no official figures are available. . . . The war demand for lead remains at a high level. Negotiations on the concentration of the lead pipe and sheet industry are understood to be proceeding satisfactorily, and the scheme should result in releasing a number of workmen for more important work. In the United States the position, although somewhat tight, is satisfactory, and the firms engaged in the national effort are reported to be getting all the metal they require. . . . Conditions in the spelter market have been somewhat stringent for a long time, and consumers have become accustomed to the careful supervision by the Control of their applications for licences. The drastic curtailment of the use of spelter in galvanising has eased the position somewhat, but, even so, the Control is maintaining a tight hand on the distribution of the metal.

Notes and Memoranda

Rail and Road

RAILWAYS IN SWEDEN.—Recent reports from Stockholm show that since 1939 some twenty privately owned railways have been absorbed by the Swedish State Railways, increasing the route mileage considerably to over 6000 miles. The electrified mileage on March 1st of this year had risen to 2600 miles.

A SPANISH LINE ELECTRIFIED.—After lying derelict for nearly seven years, the Calahorra and Amedo narrow-gauge line has been reopened to traffic, this time with electric traction, by the State. Calahorra is about 135 miles from Bilbao, on the Bilbao and Zaragoza main line, and the Amedo branch serves a southerly district which produces cereals, sugar beet, and wine.

RAILWAY RATIONALISATION IN CANADA.—The two great Canadian railways were jointly responsible for applications to abandon part of their mileage in Alberta. The scheme has been approved by a majority judgment of the Board of Transport Commissioners. The C.P.R. will abandon 64·7 miles of its Alberta Central sub-division, and the C.N.R. discontinue the operation of 6·51 miles of its line in the Brazeau sub-division. With reorganisation, the C.N.R. line should carry the combined traffic of the two, although certain grain elevators would have to be relocated.

U.S.A. RAILS MAY CROSS B.C.—Certain New York and Chicago railway interests are trying to negotiate the purchase of the Government-owned Pacific Great Eastern Railway in British Columbia. The track involved runs from Squamish, 35 miles north of Vancouver, to Quesnel, 62 miles south of Prince George. The intention is to extend the line from Quesnel, through the Yukon Territory, to Alaska, provided that the approval of the Federal Government can be obtained. It is understood that the Government of British Columbia is prepared to consider these proposals under present conditions.

RUBBER-TYRED RAIL WHEELS.—What is known in the U.S.A. as a three-unit auto-railer train has been delivered by its builders. It has been designed to operate with equal facility on and off the track, and is to carry explosives from point to point within a large mid-western ordnance plant. The locomotive is equipped with a six-cylinder, 125 H.P. Waukesha petrol engine, and calls for no special notice. Pneumatic-tyred wheels, 36in. in diameter, carry the load at all times, both on and off the rails, but flanged steel wheels (four per unit) serve to hold the cars on the rails when the train is moving on the track, these being retracted in pairs individually when it is desired to operate off the track. Raising or lowering of the flanged guide wheels is effected by compressed air, and is done in abuot 18 sec. The two trucks are of steel and are lined with plywood.

Air and Water

BELGIAN MERCHANT SHIP.—A new Belgian merchant ship, named the "Belgian Airman," has been built recently in this country and has just completed her maiden voyage across the Atlantic. She is one of seven cargo ships acquired by the Belgian Government to replace part of the Belgian merchant fleet tonnage lost since the outbreak of war.

CANADA TO DEVELOP WATER POWER.—To meet the demand for more power for increased metallurgical production in Canada the flow of water from Reindeer Lake in Northern Saskatchewan is to be brought under control. The project calls for the construction of two dams, each 80ft. long and 35ft. high. These dams will be separated by an island of solid rock.

NEW SWEDISH MOTORSHIP.—The cargo motorship "Tritonia," built by Eriksbergs mek, Verkstad, Gothenburg, for the Rederi-A/B Soya, Stockholm, has run trials, attaining a speed of 15·4 knots, the contract speed being 13½ knots loaded. *Shipbuilding and Shipping Record* says that the vessel is of the shelter-deck type, with accommodation for officers and passengers in a deck-house round the engine-room casing. She is 317ft. 6in. in length, 50ft. in breadth, and 33ft. 5in. in depth to shelter deck, and carries about 5000 tons deadweight on a draught of 24ft.

TWO NEW BRIDGES.—Last month there was opened a highway bridge across the River Niger, at Bamako, Upper Senegal, which will afford fresh access to the Trans-Sahara Railway from the southern parts of French West Africa. Another bridge recently opened is in Hungary. It crosses the River Tisza, and is a link in the 68-mile Miskolc and Debrecen State-owned road. It replaces the pontoon bridge established there in 1936. The nearest bridges up and downstream are near Tokaj, 28 miles away, and near Tiszafüred, 37 miles away. The length of the new bridge is 1312ft., of which the two steel spans bridging the bed account for 338ft. each.

Miscellanea

CANADA TO PRODUCE MORE NICKEL.—The International Nickel Company of Canada is opening new ore bodies and expanding its production plant at a cost of 35 million dollars to meet the demands for nickel for war purposes. With the new plant operating in 1943 the company's output of nickel will be approximately 50,000,000 lb. greater than in 1940.

TUNNELLING AT GIBRALTAR.—Army tunnellers working in Gibraltar's underground defences recently established a new record by mining 12,720 tons of rock in six days. This was accomplished by a force of fewer than 200 men. The previous record, apparently, was 5540 tons for the same period. The big speed-up is the result of the installation of new machinery and equipment.

WOOD TO REPLACE METAL.—According to the Forest Products Laboratories of the Department of Mines and Resources, the increasing demand for metals for war purposes and the abundance of wood in Canada have resulted in a swing-back from metal to wood for a variety of purposes and to the consideration of wood or wood derivatives for several new uses. In its natural form or after processing, wood is helping to meet a shortage of tin formerly used in bearings, containers, kitchen utensils, ornaments, roofing, small tubes and trays, and a variety of other goods. The rapid and steady development of the use of phenol and urea resin adhesives is opening up a number of new fields for plywood and improved wood.

TWO MINOR METALS.—According to the author of a paper recently read before the American Chemical Society, the surface of iron castings can be rendered resistant to abrasion by the addition of a small percentage of tellurium. Small amounts of selenium and tellurium, added to steel, copper, copper-rich alloys, and bronze make these metals more easily cut and sawn. Tellurium added to lead or lead alloys greatly improves corrosion resistance, and tellurium-lead increases in strength and toughness as it is rolled or stretched. Used in rubber, these metals increase resistance to heat and abrasion, and rubber so made is used as covering on portable electric cables for jobs where the cable receives rough treatment.

F.B.I. AND THE ORGANISATION OF INDUSTRY.—It will be recalled that the Federation of British Industries in its recent report on reconstruction stated that industry was prepared to reconsider all the implications of industrial organisation, but that the Government, on its side, must define its attitude towards trade associations and pursue a consistent policy towards them. In pursuance of this recommendation, the Grand Council of the Federation of British Industries has authorised the President to appoint a committee to consider the questions affecting the trade association movement of the country and to submit a report to the Federation based upon its study of the problem and the evidence which it receives from its trade association members. It is announced that Sir Charles Bruce-Gardner, M.I. Mech. E., has accepted the chairmanship of this new committee, which will begin its work at an early date.

SUN BATHS FOR WORKERS.—A successful experiment has been made at the Argus Foundry, Thornliebank, of G. and J. Weir, Ltd., by installing spray baths and sun lamps for the use of the men and women workers. The sprays are available to both day and night shift workers every day of the week, the workers being divided into groups, and a rota drawn up giving times of use. Separate steel lockers are provided for men and women workers, each of whom is given a locker key. As a result, they can come to their work at the start of the shift in clean outdoor clothes and change into their working clothes, leaving their outdoor clothes in the locker. At the end of the shift they can go to the locker room, and taking off their working clothes—bringing their own towel and soap—pass into the spray room, where there are twenty-two individual spray cubicles with adjustable hot and cold water supplies. From the sprays they pass into the solarium, where four industrial welfare sun lamps, supplied by Hanovia, Ltd., of Slough, have been installed. After two minutes in front of these lamps they return to the locker room, where they can dress in their clean clothes ready to get their tea in the canteen. Shop stewards take it in turn to supervise the locker rooms and a trained nurse or a trained member of the first-aid corps is in charge of the solarium. Workers must obtain their doctor's permission before making use of the sun lamps, and anyone suffering from an infectious disease is forbidden the use of the sprays.

THE QUEST FOR TUNGSTEN.—According to a report sent from Chungking, the Kiangsi deposits of tungsten are an objective of the Japanese drive into the provinces of Chekiang and Kiangsi. Meantime, that metal is included in the plans that have been worked out under which the American Reconstruction Finance Corporation will finance the development of certain mines in Canada to relieve the present shortage of lead, zinc, and tungsten in the United States.

RUBBER FROM GRAIN.—In the course of an inquiry before a committee of the U.S. Senate, Mr. Claude R. Wickard, U.S. Secretary for Agriculture, stated that his Department was now convinced that alcohol produced from grain was the best and cheapest material from which to make butadiene for use in the production of synthetic rubber. Much progress had been made in the Department's laboratory at Peoria, Illinois, and his suggestion was that, say, 80 million bushels of wheat or maize might be used to make 200 million gallons of alcohol, from which ultimately about 240,000 tons of rubber could be produced.

BRAKES ON FARM TRAILERS.—In order to assist farmers, the regulations which require that a trailer may not be used behind an agricultural tractor unless it is fitted with brakes complying with the Motor Vehicles (Construction and Use) Order are being amended. Under a new regulation, made by the Minister of War Transport, an agricultural trailer drawn by a motor tractor need not be fitted with brakes if the laden weight of the trailer does not exceed 4 tons and the speed does not exceed 10 miles an hour. This exemption does not apply if more than one trailer is being drawn. The concession holds good for the duration of the war only. The concession will enable a farmer to use his farm wagon for road haulage behind his tractor.

Personal and Business

MR. SAMUEL JACKSON has been elected to the board of Beyer, Peacock and Co., Ltd.

LORD BRABAZON has been elected a director of the London Electric Supply Company.

MR. J. G. SHAW has been appointed vice-chairman of Lancashire Dynamo and Crypto, Ltd.

MR. W. J. H. WOOD, engineer-in-chief of the County of London Electric Supply Company, Ltd., has been appointed a director of the Kent Electric Power Company.

MR. F. V. HASEMORE and Mr. C. G. Seeley have been appointed joint managing directors of the Edison Swan Electric Company, Ltd., and of Edison Swan Cables, Ltd.

MAJOR L. H. PETER, M.I.E.E., formerly chief electrical engineer of the Westinghouse Brake and Signal Company, Ltd., has been appointed chief engineer of that company.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Fuel Luncheon Club

Tuesday, July 21st.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon, 12.40 for 1.10 p.m.

Institute of Fuel

To-day, July 17th.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon meeting to Major Gwilym Lloyd George, M.P. 12.45 for 1.15 p.m.

Institution of Automobile Engineers

Tuesday, July 21st.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "A Post-war Motor Vehicle," L. H. Hounsfield. 6.30 p.m.

Wednesday, Aug. 19th.—LUTON CENTRE: George Hotel, Luton. General meeting. 6.30 p.m.

Institution of Electrical Engineers

Sunday, July 19th.—LONDON STUDENTS: Summer outing to Ashtead.

Institution of Mechanical Engineers

To-day, July 17th.—APPLIED MECHANICS GROUP: Storey's Gate, Westminster, S.W.1. "The Measurement of Torsional Vibrations," R. Stansfield. 5.30 p.m.